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TAIWAN'S AGRICULTURAL DEVELOPMENT:

**ITS RELEVANCE
FOR DEVELOPING
COUNTRIES TODAY**

U.S. DEPARTMENT OF AGRICULTURE
ECONOMIC RESEARCH SERVICE

TAIWAN'S AGRICULTURAL DEVELOPMENT

Its Relevance for Developing Countries Today

**U.S. DEPARTMENT OF AGRICULTURE
Economic Research Service
Foreign Development and Trade Division**

FOREWORD

To provide better knowledge for planning and implementing country development programs in the less-developed countries, the Agency for International Development asked the Economic Research Service of the U.S. Department of Agriculture to conduct research on a project entitled "Factors Associated With Differences and Changes in Agricultural Production in Underdeveloped Countries." Phase 1 of the research has been completed, and was reported in "*Changes in Agriculture in 26 Developing Nations, 1948-63*" (Foreign Agr. Econ. Rpt. No. 27, Economic Research Service, U.S. Department of Agriculture, November 1965). That report made a comparative analysis of rates of growth in agricultural output and factors affecting them.

Phase 2 of the research, a part of which is reported here, involves making a detailed analysis for selected countries of the specific relationship between factors and processes of change in agricultural output. The countries selected are Greece, Taiwan, Mexico, Brazil, Colombia, India, and Nigeria. The studies are being conducted by agricultural economists from the Economic Research Service, in cooperation with research organizations in each country.

This report is on the history of agricultural development in Taiwan. The research findings indicate that the output of Taiwan's agriculture increased at an annual rate of 4.5 percent a year, beginning in the 1950's. This rate of growth in agricultural productivity helped achieve a national income growth rate of 7.6 percent a year and a per capita income growth rate of 4.2 percent.

The report, in addition to describing Taiwan's agricultural development since the early 1900's, gives detailed attention to the structure of the institutional organizations that made rapid agricultural growth possible.

DIRECTOR, AGRICULTURAL AND RURAL DEVELOPMENT SERVICE
OFFICE OF THE WAR ON HUNGER

AGENCY FOR INTERNATIONAL DEVELOPMENT

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SUMMARY

Taiwan has become an important export market for U.S. products—\$333 million in 1967, including \$111 million worth of agricultural products. Taiwan's rapid economic growth made possible the cessation of U.S. economic aid and technical assistance in 1965, although Public Law 480 shipments have continued as needed.

Increases in agricultural productivity have helped Taiwan achieve a high rate of economic growth. Taiwan's national income measured in real terms has increased at a yearly rate of 7.6 percent since the early 1950's. Total agricultural output has increased at a yearly rate of 4.5 percent. Gains in agricultural productivity—larger outputs per hectare, per worker, and per unit of all resources combined—account for more than half of the growth in total agricultural output since the early 1950's.

Taiwan's experience in achieving large gains in agricultural productivity should be of interest to many other developing countries because they share many points of similarity: Rapid population growth, limited land resources, tropical climate, need for irrigation improvements, a long colonial history, and the like. Taiwan has many unique points in its development that might be adopted or adapted by other countries.

During the Japanese colonial period, 1895–1945, Japan effected an energetic development program designed chiefly to grow food for Japan. Japan put money into the infrastructure of the island: constructing irrigation projects and transportation facilities; introducing fertilizer and disease and pest control measures; initiating agricultural research and education; and supporting local farmers' organizations that channeled technological information, production supplies, and marketing aids to farmers. Agricultural output increased more rapidly than population. Large amounts of rice, sugar, and other farm commodities were exported to Japan.

Due to disturbances of war, agricultural production had dropped to less than half of the 1939 level when Taiwan was restored to China in 1945. Effective rehabilitation and recovery programs caused agricultural output to increase quickly to the 1939 prewar peak level by 1951. But the population growth rate increased to over 3.5 percent a year in the 1950's as birth rates continued high and death rates declined with improved health and sanitation services. Consequently, Taiwan

was faced with the task of accelerating the rate of growth in agricultural output to provide the food supplies required by higher population. More production also was required to increase per capita consumption levels to meet demands for food resulting from higher per capita incomes and to increase exports.

Potentials for obtaining large increases in agricultural production by expanding the land area under cultivation and increasing the irrigated area had been quite fully exploited by 1945. Increased production per cultivated hectare was required. This was achieved by the introduction of superior crop varieties, improved irrigation facilities, increased multiple cropping, more effective control of diseases and pests, increased use of fertilizer, and shifting land to labor-intensive crops that have a high value per hectare.

Taiwan owes much of its present economic health to three major developments. The first was land reform. This included reduction of land rentals and in 1949, sale of Government-owned land to farmers, and the land-to-the-tiller program beginning in 1953, under which tenant farmers were helped to become landowners. The second was reorganization in 1953 of farmers' associations and cooperatives to put them under more direct control of farmers. The third was agricultural development planning, launched in 1953 with the first of successive 4-year plans, which helped achieve effective use of scarce land, water, fertilizer, and other inputs.

Taiwan's agricultural development strategy was a multiphase approach that gave attention to many things—education, research, extension, credit, price incentives, marketing and storage facilities, and infrastructure for irrigation, drainage, roads, and the like.

Taiwan's experience indicates that small owner-operated farms can be highly productive if supporting services are provided. Farms decreased in size from an average of a little over 2 hectares in the early 1950's to about 1 hectare in 1966, but output and sales per farm increased.

Evidence shows that farmpeople in Taiwan do respond to economic incentives. They will give up age-old methods for more productive and profitable new ones. And they will shift readily from one crop to another if it means more money for them.

Taiwan's Agricultural Development: Its Relevance for Developing Countries Today

By Raymond P. Christensen, Director, Foreign Development and
Trade Division, Economic Research Service

CHAPTER I.—WHY STUDY TAIWAN?

Rapid Economic Progress

Taiwan's economic progress is remarkable. National income measured in real terms has increased at a yearly rate of 7.6 percent since 1952. Per capita income has increased at a yearly rate of 4.2 percent. These high growth rates have been achieved despite rapid population growth, limited natural resources, and large expenditures for defense.

Economic aid and technical assistance supplied by the United States were important factors contributing to rapid economic growth in Taiwan. Economic aid totaled nearly \$1.5 billion for the fiscal years 1951-65, or about \$100 million a year.¹ This amount includes the value of agricultural commodities supplied under Public Law 480 and development loans, as well as general economic aid for defense support and other purposes.

Economic progress in Taiwan made possible the discontinuation of U.S. economic aid in 1965. Taiwan now can attract from abroad the capital it needs to help finance its economic development and can pay for needed imports with exports. Taiwan's exports of goods and services increased from about \$120 million in 1952 to \$569 million in 1966 or from \$14 to \$44 per capita.

Taiwan has become an important export market for the United States. Imports from the United States totaled \$333 million in 1967 including imports of \$111 million of agricultural products.

Taiwan can best be described as in the transitional stage of economic development. The agricultural population (people living on farms) as a percentage of total population declined to 45 percent in 1966, compared with 26 percent in Japan and 66 percent in the Philippines. However, per capita income in Taiwan still averages a little under \$200 a year. But per capita income probably does not fully reflect the eco-

¹ Dollar values in this report are U.S. dollars, unless preceded by the initials NT to indicate Taiwan dollars.

conomic welfare of people in Taiwan, compared with people in the developed countries. The purchasing power of the dollar is 25 to 50 percent higher in Taiwan than in most developed countries. Most people in Taiwan consume nutritionally adequate diets and enjoy good health facilities. Life expectancy at birth is 66 years in Taiwan, compared with 70 years in the United States. Approximately 97 percent of the primary-school-age children attend school and 75 percent of the total population are literate.

Gains in Agricultural Productivity

Economic development in Taiwan has depended heavily upon improvement in agricultural productivity. Taiwan now has only 0.17 acre (0.07 hectare) of cultivated or arable land per capita, compared with 2 acres in the United States. But crop production per acre has been raised to a very high level. In fact, value of crop production per acre now averages about 6 times higher in Taiwan than it does in the United States.

Gains in agricultural productivity in Taiwan have made possible the net transfer of large amounts of capital and large numbers of workers from agriculture to other sectors and thereby have contributed to the economic growth in the rest of the economy. Large increases in output per acre and per agricultural worker have been achieved with modest increases in capital inputs from other sectors of the economy.

Population growth in Taiwan increased from 1.3 percent a year in 1910-20 to 2.3 percent a year in 1920-30 and 2.7 percent in 1930-40. Death rates declined without comparable reductions in birth rates. However, agricultural output growth rates, based on linear trend estimates, also accelerated from about 2.2 percent a year in 1910-20 to over 4 percent a year in 1920-30 and to about 3 percent a year in 1930-40. Agricultural production per capita increased over 40 percent from 1910 to 1935 (fig. 1). Agricultural production, of course, dropped drastically with the disturbances of war in 1940-45.

The rapid recovery and expansion of agricultural production after 1945 is remarkable. Potentials for obtaining large increases in agricultural output by expanding the land area under cultivation, increasing the irrigated area, and using more fertilizer had been quite fully exploited by 1945. Population growth accelerated to 3.6 percent a year in 1950-60 as death rates continued to decline. But agricultural output increased 4.3 percent a year, causing agricultural output per capita to increase nearly 20 percent. Agricultural output has increased 4.6 percent a year since 1961, but the annual rate of population growth declined to 2.8 percent in 1966 due to lower birth rates.

Taiwan faces the task of achieving even higher crop yields in the years ahead, as the possibilities for expanding the area under cultivation are very small. In fact, new land brought under cultivation

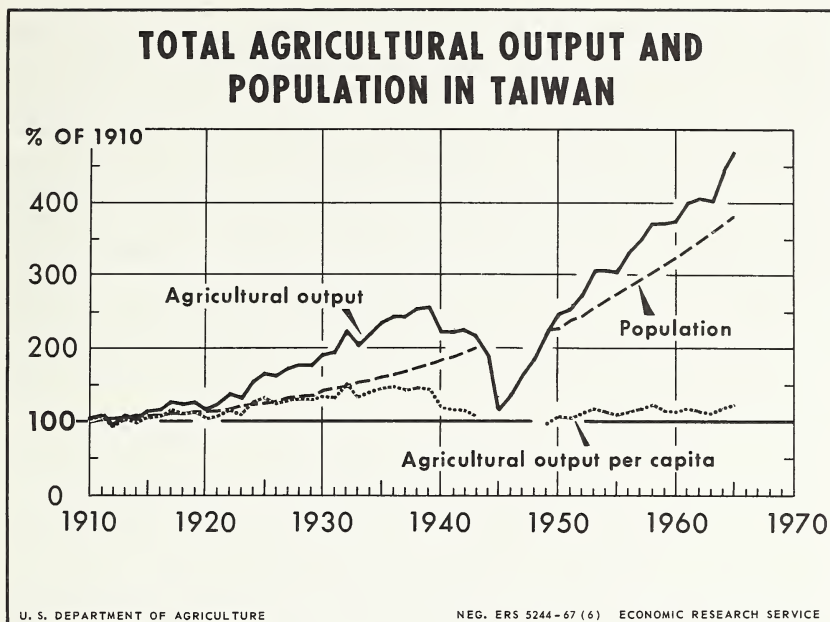


FIGURE 1

through irrigation and other land improvement measures in the last 15 years has been offset by the loss of fertile agricultural land to industrial and urban uses. The agricultural labor force can be expected to continue to increase in the next few years, even though the total population growth rate declines. Ways must be found to raise agricultural production per worker if agriculture is to contribute to overall economic development. And this must be done with small additional inputs of capital from nonfarm sources since capital will continue to be relatively scarce.

Key Questions

A major purpose of this report is to examine Taiwan's agricultural development experience to determine what relevance it may have for other developing countries. However, it is hoped that this study also will be useful in planning and implementing Taiwan's agricultural development in the future.

Taiwan's experience in achieving higher levels of productivity in agriculture may have important lessons for other developing countries, especially those where population is increasing rapidly and the possibilities of bringing additional land under cultivation are limited.

How much has agricultural productivity increased in Taiwan and how has this contributed to development of the rest of the economy? Total agricultural output in Taiwan has increased relative

to total input of land, labor, and capital measured in real terms. In fact, the use of additional inputs of land, labor, and capital accounts for only half of the rise in total output since 1910. Approximately half is attributable to increased output per unit of input. This rise in agricultural productivity has made possible higher levels of consumption for rural people and at the same time a net transfer of capital and labor from agriculture to other sectors of the economy. Thus, growth in agricultural productivity has supported overall economic growth. Chapter III examines the agricultural productivity record of Taiwan since 1911, based mainly on a study by Hsieh and Lee (15).² Chapter IV considers the interrelationships between agriculture and the rest of the economy and measures the net transfer of capital and labor from agriculture to other sectors.

What is the source of the increased agricultural production not explained by the conventional inputs: Land, labor, and capital? This is a major question. The answer is not simple. New, improved production methods obviously are essential for achieving higher productivity levels. But how is a continuing stream of improved technology generated? How are farmers persuaded to adopt improved technology? How large were the investments in research and education and why were they so effective? These questions are considered in Chapter V.

How does structural organization of farming affect agricultural productivity? Do farms need to be large to be efficient and have a market surplus? Taiwan is a land of many small farms. In fact, average size of farm decreased from about 2 hectares in 1925 to 1 hectare in 1965. Total farm population more than doubled. Therefore, it was necessary to reduce sizes of farms or to employ more workers per farm. This is a situation faced by many developing countries today where land resources are limited and population growth is rapid (7, 20). In former years, a large share of Taiwan's farmers were tenants but land reform has been carried out and most farmers now are owner-operators. How farm size and land tenure arrangements have influenced farmers' investments, incentives, and economic welfare is considered in chapter VI.

How was effective use of water and land resources achieved? This question is important for many developing countries that are exhausting the possibilities of increasing agricultural production by bringing additional land under cultivation and must rely on increased production per acre to meet expanding food needs. For many years Taiwan has made relatively full use of its land resources, but in recent years it has made more effective use of its water resources. How land and water resources have been developed in Taiwan is considered in chapter VII.

² *Italic numbers in parentheses refer to items in the Bibliography. p. 91.*

The introduction of technological innovations involves the use of additional capital inputs. How much capital from nonfarm sources is required to step up productivity in agriculture? How can these inputs be made available most effectively to farmers through credit or other means? The use of fertilizer, pesticides, and other capital inputs and the returns to these inputs are discussed in chapter VIII. Taiwan's experience in achieving large increases in agricultural production by using additional capital inputs, especially fertilizer and pesticides, should have much relevance for other developing countries that need to increase crop yields in the years ahead.

It is generally recognized that incentive prices and assured market outlets for farm products are needed to motivate farmers to use improved technology and capital inputs to expand agricultural production. But how high are incentive prices? How is efficient marketing achieved? Taiwan has followed price and marketing policies designed to achieve intensive use of land and labor, diversify its production, and take advantage of market opportunities for farm products abroad as well as at home. How it has done this is described in chapter IX.

Taiwan still has agricultural development problems ahead because of rapid population growth and extreme scarcity of land resources. The steps being taken to solve these problems are examined in chapter X.

What was Taiwan's agricultural development strategy? What things were done, especially at the farm level, to overcome obstacles to improvements in agricultural productivity? As explained in chapter XI, Taiwan's agricultural development strategy can best be described as an integrated package approach which included infrastructure investments for developing land and water resources; agricultural experimentation, demonstration, and extension; the building of local farmer service organizations; land reform; and local and national planning and program implementation to assure market outlets at incentive prices and to achieve efficient resource use.

Finally, the relevance of Taiwan's experience in overcoming agricultural development problems to other developing countries is considered in chapter XII. It is recognized that the transfer of lessons learned in one country to another is fraught with difficulties as conditions in each country and often in regions within countries are unique.

CHAPTER II.—BACKGROUND

Natural Conditions

Taiwan (Formosa) is not large—only 240 miles from north to south and about 90 miles across at the widest point (fig. 2). It covers 14,000 square miles, slightly less than the Netherlands. Like the Netherlands, Taiwan has few precious minerals, but it does have a large volume of

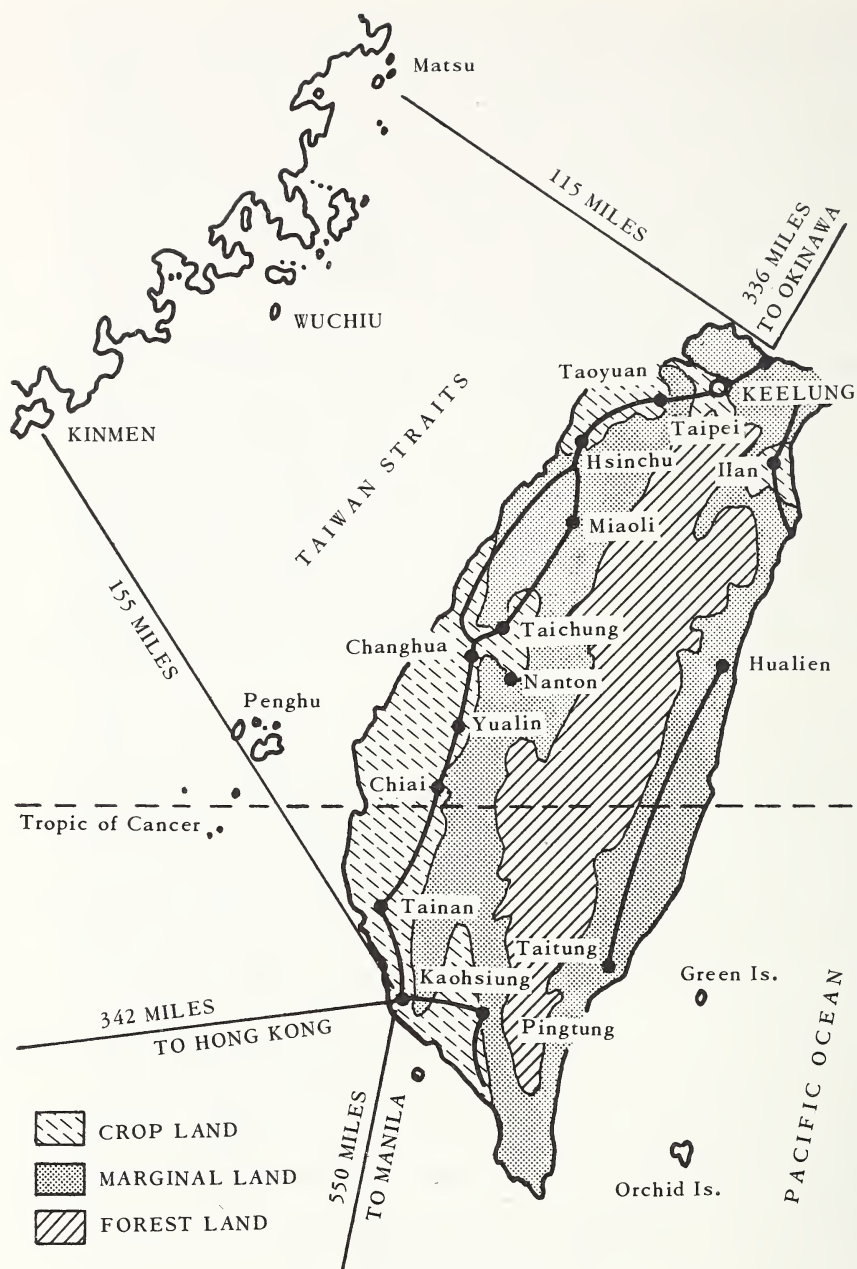


FIGURE 2. Taiwan.

low-quality coal and some natural gas, the basic raw material for nitrogen fertilizer. Total population in Taiwan now is nearly 13 million, about the same as in the Netherlands. Taiwan has only 0.07 hectare (0.17 acre) of arable land per person—about the same as the Netherlands, but the Netherlands has much larger areas of permanent pastures and meadows.

The topography and climate of the island made it inhospitable for settlement for many years. Taiwan is at the fringe of the Tropics, and the climate is hot and rainy with marked changes in season and variation from one season to another. Over half of the total area is covered with rugged mountains, rising steeply from a plain along the western coast to elevations above 11,000 feet and extending to the Pacific Ocean on the east. Heavy rainfall therefore runs off quickly, causing torrential floods. Large parts of the island are frequently swept by typhoons and shaken by earthquakes. The cultivated area accounts for only 24 percent of the total land area. Most of the hilly and mountainous land is covered with forests.

Shen (32) points out that "the natural conditions of Taiwan offer many opportunities but also demand a high level of technology." Variations in temperature and altitudes make it possible to grow many different plants and animals. Subtropical and tropical climates on the plains make possible the growth of three or four crops a year but irrigation is necessary because of uneven rainfall. Rainfall varies from less than 40 inches a year along the west coast to over 160 inches in some parts of the mountains. It is fairly well distributed throughout the year in the northern part of the island, but in the southern part over 85 percent falls in the months from April through September. The tropical climate causes rapid decomposition of organic matter, and leaching of the mineral content of the soil. Flood control measures are required to reduce soil erosion. Fertilizer is needed to build up soil productivity. Diseases and insects multiply rapidly and pesticides are required for their control.

In brief, natural conditions in Taiwan are similar to those in other tropical areas where a high level of technology is required for productive agriculture. The productivity of soils in Taiwan was not high originally. It has been built up through the incorporation of organic matter, application of fertilizer, irrigation and flood control measures, and advanced farming methods.

Early Settlement

Prior to 1600, Taiwan was sparsely settled by a few tribes, mainly people now referred to as aborigines (4). Chinese migration to the island took place mainly after 1660. Population increased slowly from a few thousand in 1600 to more than 2 million in 1895. In the process of settlement, Taiwan became thoroughly imprinted with the characteristics of Chinese culture. Chinese settlers came mainly from the prov-

inces of Fukien and Kwangtung in southeast China. They introduced rice, sugarcane, sweet potatoes, water buffaloes, and Chinese farming methods. Some irrigation systems were built for growing rice.

Taiwan was ruled from Peking, first as a part of the province of Fukien, and after 1886 as a separate province. Powerful families living in rural areas in Taiwan, rather than rulers from Peking, governed the rural villages. The large landowning families relied upon property obligations owed them by tenants to maintain political stability and order in the rural areas. These powerful families in turn had obligations to the rulers in Peking.

Sugar production was started by the large landowning families on plantations and also on small rented units. Sugar and rice were exported. Trade was mainly with mainland China.

Japanese Colonial Period

Taiwan was ceded to Japan at the end of the Sino-Japanese War in 1895. Attention was placed first upon establishing law and order and political and economic control. Beginning in the early 1900's, policies and programs were initiated for expanding production and exports of rice, sugar, and other crops, chiefly to Japan, and for building up transportation, communications, and other infrastructure facilities needed for the support of agricultural development. These policies were eminently successful, as shown by the rapid rise in total agricultural output in the 1920's and 1930's (fig. 1). Emphasis was placed first on expanding production and exports of sugar and rice. Production of sweet potatoes increased sevenfold and rice fourfold between 1900 and 1938.

Food consumption levels apparently did not rise much during this period. Rice consumption increased slowly from 1910 to 1935 because the Japanese encouraged the use of sweet potatoes for food—a less preferred commodity, but one that yielded more calories per acre. The bulk of the increased production of rice was exported to Japan. After 1932, the Japanese required increased sugar production; it reached a record high of 1.4 million metric tons in 1938–39. Emphasis again was placed upon production of rice for export to Japan after 1940. Over 90 percent of Taiwan's exports went to Japan and Korea in 1935–39.

The Japanese colonial government put into effect an energetic economic development program. Detailed population censuses were taken in Taiwan in 1905 and again in 1915 for purposes of control and regulation. A detailed land survey carried out in 1902–04 provided the basis for land taxation programs. Law and order were maintained through the pao-chia system under which virtually all Taiwanese were assigned to household groups (chia) which in turn were grouped into village units (pao) for supervision. Responsibilities for law observance and public order were allotted jointly among households of

each village. Positions of authority with defined duties were conferred on heads of prominent families. Regulation of villages followed lines of kinship and property. Each chia as a group had many duties such as reporting births, deaths, and movement of people; mobilizing labor for roadbuilding and irrigation projects; disseminating instructions on crop improvement and soil maintenance; putting into effect health and sanitation measures; supporting schools; and collecting taxes. Thus, the Japanese relied upon an efficient system of indirect rule for local government purposes, but at the same time they maintained their own police force.

Many of the rural institutional organizations found in Taiwan today can be traced to the Japanese colonial period. The Japanese, for example, established agricultural research stations, vocational agricultural schools, farmer organizations to introduce improved farming methods, market farm products, and distribute production requisites, and irrigation associations for supplying water to farmers. Extension education in improved agricultural methods and distribution of improved crop varieties were carried out through farmer associations and small agricultural units in the villages. Japanese administrators and technicians managed and operated the farmer organizations.

Government-owned enterprises played a big role. They constructed and operated railroads and other communication facilities, and operated electric power companies, large-scale facilities for irrigation and flood control, and facilities for processing agricultural products. Government holdings in private corporations dominated many individual enterprises. In 1936, the Japanese Government established the Taiwan Development Corporation as a supercorporation dominating all others in preparation for World War II.

The Japanese agricultural policy was one of providing farmers with the capital improvements they needed for increasing productivity of land and labor. The Japanese provided the administrative framework through which technological advancements in agriculture were introduced. Gains in agricultural productivity were facilitated by development of transportation and communication, education, health facilities, and land and water improvements. Throughout the Japanese colonial period, emphasis was placed on investments required to expand output of agricultural products needed for economic development in Japan. Industrial development of Taiwan was given a lower priority.

Restoration to China

Taiwan was restored to Chinese sovereignty in 1945 and has been the seat of the Government of the Republic of China since 1949. Because of damages to irrigation and flood control systems, lack of fertilizer, and unsettled conditions caused by the war, total agricul-

tural output in 1945 had declined to less than half the level that prevailed in the late 1930's. Consequently, the first task the Government faced in agriculture was one of rehabilitation and restoration of agricultural production. Total agricultural output recovered to the prewar level in 1951. It has gone up at record high rates annually since then.

Large numbers of people moved from mainland China to Taiwan after 1945. The Japanese population decreased from 356,000 in 1945 to nearly zero, but this was offset in part by the return of nearly 100,000 Taiwanese repatriates from Japan. The large migration from mainland China caused the population of Taiwan to swell suddenly from 6.6 million in 1945 to 7.6 million in 1950, not including 600,000 men in the armed forces (14). Since 1950 the population of Taiwan has nearly doubled and now totals 13 million.

Three developments of an organizational nature which have contributed greatly to Taiwan's agricultural progress were carried out in the early 1950's. The first was land reform, initiated with rent reduction in 1949, sale of Government-owned land to farmers, and the land-to-the-tiller program in 1953 under which tenant farmers became landowners. The second was reorganization of farmers' associations and cooperatives in 1953 to put them under control of farmers. The third was initiation and implementation of comprehensive national agricultural development plans, beginning with the first 4-year plan in 1953. More will be said about these developments later. The major Government and private agencies that have been concerned with agricultural development in Taiwan are described below.

Joint Commission on Rural Reconstruction

The Chinese-American Joint Commission on Rural Reconstruction (JCRR) was established at Nanking on October 1, 1948, under the China Aid Act of the United States. It has played a leading role in Taiwan's agricultural development. As stipulated in the act, the Commission was authorized to formulate and carry out a coordinated program for reconstruction in rural China. The act provided that 10 percent of the funds made available under aid programs to China be used for programs authorized by JCRR. The Commission moved to Taipei in the fall of 1949. JCRR has been the binational agency through which U.S. technical assistance, economic aid, and food aid for rural development to the Republic of China have been channeled.

As pointed out by Tsiang (35), "The role played by JCRR in agricultural development has been that of a catalytic agent. By providing technical and some financial assistance, JCRR has been able to stimulate improvement in agricultural policies and implementation methods, to motivate projects difficult to activate, and to generate a self-help spirit among the local agencies." In selecting activities or programs to support, JCRR requires that there be (1) a felt need for the services

and activities on the part of rural people, (2) fair distribution of benefits, (3) a sponsoring agency qualified to utilize the assistance and carry on the activities or programs after JCRR support is withdrawn, and (4) a demonstration of the feasibility of any particular project before undertaking its broad expansion.

JCRR has been a semi-independent organization subject to policy direction and fiscal control on the U.S. side by the Director of the Agency for International Development (AID) Mission to China. JCRR acted as the agricultural arm of the AID Mission and included in its functions those normally carried out by food and agriculture or rural development divisions of other AID Missions. On the Chinese side, JCRR is subordinate to the Executive Yuan (central government) and subject to the direction and supervision of the Premier. In program preparation and operations, JCRR has worked closely and coordinated its activities with the Council for International Economic Cooperation and Development (CIECD), the Ministry of Economic Affairs (MOEA), especially its Agricultural Planning and Coordinating Committee (APCC), and other relevant agencies.

The APCC had responsibility for preparing 4-year agricultural development plans in cooperation with the CIECD and the MOEA. A Commissioner of JCRR served as convenor (chairman) and a JCRR economist as secretary of the APCC. Also participating in APCC's work were other JCRR commissioners and specialists of other agencies. APCC was abolished in October 1963 and its functions transferred to the Agricultural Production Committee (APC) of CIECD, but a JCRR Commissioner still serves as convenor and the staff of the Office of Planning and Programing of JCRR serves as secretariat.

The APCC of MOEA in the past and the APC of CIECD since 1963 have been responsible for planning and supervising agricultural programs and for coordinating programs, operations, and budgets of agricultural agencies. About 60 persons with special knowledge of food crops, special crops, forestry, fisheries, animal industry, and water conservancy hammer out the actual plan. Final drafts are submitted to the Executive Yuan for approval. After the plan has been approved, additional meetings are held to decide how best to carry out the plan. JCRR thus is involved in overall planning, project planning, and field implementation.

JCRR continues as a binational agency between the United States and Chinese Governments although the AID program to China was discontinued in 1965.

Government Agencies

Both the Executive Yuan and the Provincial Government of Taiwan have responsibilities in agriculture.

The total number of agricultural personnel in all Government agencies on Taiwan in 1963 was 9,056 excluding 184 JCRR staff mem-

bers (table 1). The number has not changed greatly since 1963. Major agencies concerned with agriculture can be described briefly.

TABLE 1.—*Number of agricultural personnel in Government agencies in Taiwan, 1963*¹

Government agency	Number
Central Government:	
Agricultural Production Committee, CIECD ² -----	-----
Department of Agriculture, MOEA-----	8
Department of Water Conservancy, MOEA-----	8
Water Resources Planning Commission-----	300
Tidal Land Planning Commission-----	40
Subtotal-----	356
Taiwan Provincial Government:	
Provincial Department of Agriculture & Forestry-----	362
Provincial Food Bureau-----	1,750
Provincial Forestry Administration-----	2,318
Provincial Water Conservancy Bureau-----	915
Provincial Fisheries Administration-----	101
Mountain Agricultural Resources Development Bureau-----	122
Subtotal-----	5,568
All research institutes and experiment stations (34)-----	1,096
County and city offices (22):	
Agricultural, forestry, fishery sections of their reconstruction divisions-----	660
Irrigation sections-----	176
Subtotal-----	836
Town and township offices (300):	
Agricultural and forestry sections of their reconstruction divisions-----	1,200
Total-----	9,056

¹ Data are from (35, p. 16). Numbers in parentheses show number of offices.

² The personnel of the APC Secretariat are not included because they are staff members of the JCRR Office of Programing and Planning.

The Water Resources Planning Commission (WRPC) in the National Government is organized by MOEA for overall planning of multipurpose projects. It has about 300 employees, 70 percent of whom are engineers.

The Provincial Department of Agriculture and Forestry (PDAF) is a division of the Provincial Government of Taiwan financed from a budget allocated by the provincial assembly. It has responsibility for seven district agricultural improvement stations, six experiment stations, and various research centers, training centers, and laboratories located throughout the country.

The Provincial Food Bureau (PFB) is responsible for the collection of rice through fertilizer barter and rural land taxation and the supply of rice to military and civilian Government employees under the Government ration system. It releases rice for sale to markets for price stabilization purposes, handles exports and imports of rice, registers domestic rice merchants, and carries out other food administration activities.

The Provincial Forestry Administration (PFA) is responsible for the management of Taiwan's timber and for reforestation and forest

management. It operates seven district forest offices and six logging stations and is engaged in marketing logs and saw timber. It also maintains nurseries which produce seedlings for forest replanting.

The Mountain Agricultural Resources Development Bureau (MARDB) was created within the PDAF in 1961 in response to a need shown by a JCRR-sponsored survey of the crop-forest marginal zone, for better soil conservation measures and for rational planning to exploit the untapped resources of the hill country. It has responsibility for soil conservation work in "reservoir" watersheds and provides technical help to soil conservation offices of the *hsiens* (counties).

The Provincial Fisheries Administration (PFA) is responsible for development of fishery industries including pond fish culture, inshore and offshore fisheries, and deep-sea fishing. It is engaged in rehabilitation of fishing harbors and supervises fishermen's associations, especially their marketing activities.

The Provincial Water Conservancy Bureau (PWCB), an agency of the Provincial Department of Reconstruction, has planning, design, construction, and administration divisions, and 12 construction offices which plan, design, and construct principal river flood control projects as well as major irrigation projects. It has about 1,500 employees, including 500 engineers.

Public Enterprises in Agriculture

The Taiwan Sugar Corporation (TSC) is a public enterprise responsible for planning and coordinating sugarcane production and processing and marketing sugar. It produces sugarcane on land owned by the Corporation but about 70 percent of total sugarcane acreage is grown by small private farmers under contract. It also conducts research on problems relating to sugarcane production and processing.

The Taiwan Tobacco and Wine Monopoly Bureau (TTWMB) is a public enterprise responsible for production and sale of tobacco products and wine. It enters into contracts with farmers for the production of tobacco, carries out processing and marketing activities, and also conducts research on tobacco problems.

The Taiwan Land Bank and the Taiwan Cooperative Bank are independent State enterprises that make loans to farmers and marketing firms.

Agricultural Associations and Cooperatives

In 1963 Taiwan had 340 farmers' associations, six fruit marketing cooperatives, 78 fishermen's associations, and 27 irrigation associations carrying out field programs. They employed over 12,000 people (table 2).

Farmers' associations are multiple-service organizations with membership covering about 90 percent of all farm families. They provide cooperative marketing and purchasing services and also warehousing

TABLE 2.—*Number of personnel employed by agricultural associations and cooperatives, Taiwan, 1963*¹

Organization	Number
Farmers' associations:	
Provincial farmers' association (1)-----	115
Hsien/city farmers' association (22)-----	707
Hsiang/township farmers' association (317)-----	7, 070
Fruit marketing cooperatives:	
Provincial fruit marketing cooperative (1)-----	23
Local fruit marketing cooperative (5)-----	244
Fishermen's associations:	
Provincial fishermen's association (1)-----	24
Local fishermen's associations (77)-----	1, 230
Irrigation associations:	
Provincial irrigation association (1)-----	19
Local irrigation associations (26)-----	2, 639
Total-----	12, 071

¹ Data are from (35, p. 20). Numbers in parentheses show number of associations.

and processing facilities for members. Most of them operate credit departments to accept farmers' savings and extend loans to farmers. They also have extension departments to carry out adult education, home demonstration, and 4-H programs.

Fruit marketing cooperatives, fishermen's associations, and irrigation associations also play an active role in serving members. The six fruit marketing cooperatives have a national federation to coordinate their activities. One cooperative has facilities for canning fruits and vegetables.

Role of Private Enterprise

There are many small private business firms engaged in marketing farm products and selling supplies to farmers. For example, there are about 60 business firms that distribute pesticides. Many small business firms market fruits and vegetables. Retail trade in food products is conducted by many small private enterprises, and several firms can fruits and vegetables.

CHAPTER III.—THE AGRICULTURAL DEVELOPMENT RECORD

Agricultural output as referred to here includes only crop and livestock production, except that the discussion on foreign trade includes fishery and forestry products. However, large increases also have been achieved in fishery and forestry production. Fishery production was 3.1 times larger in 1965 than in 1952 while forestry production was 2.4 times larger. Taiwan is utilizing its large potentials for expanding forestry and fishery production.

Approximately three-fourths of Taiwan's agricultural production consists of field crops, fruits, and vegetables, and about one-fourth is

livestock and poultry products. Swine account for about 16 percent of total agricultural production. The percentage distribution of the total value of the major categories of agricultural products produced in 1965 was as follows:

Agricultural Products:	Percent
Common crops (rice, sweet potatoes, soybeans, etc.)-----	47.0
Special crops (sugarcane, tea, etc.)-----	13.7
Fruits (bananas, pineapples, etc.)-----	8.5
Vegetables including mushrooms-----	6.1
Livestock and poultry products-----	24.7
Total -----	100.0

Farm production is carried out on many small farm units. The number of farms increased from 366,000 in 1907 to 854,000 in 1966. Average size of farm decreased from 1.8 hectares in 1907 to 1.05 hectares in 1966. But because of increased multiple cropping, the planted crop area per farm has decreased only slightly.

Overall Changes in Productivity

Taiwan has an outstanding record of improving agricultural productivity. Total agricultural output has increased much more than total conventional inputs of land, labor, and capital (fig. 3). Agricultural output per unit of input more than doubled from 1911 to 1965. Measured in real terms or in constant prices, input per unit of

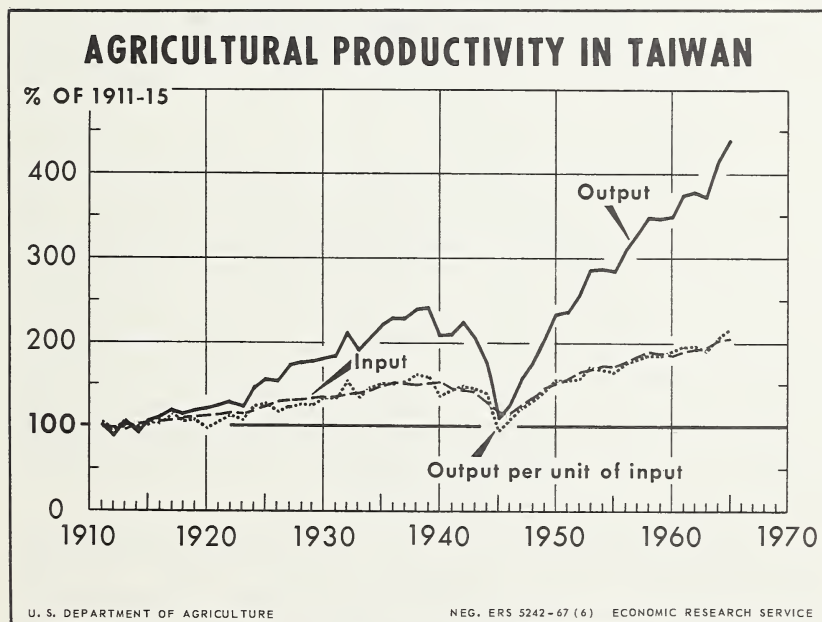


FIGURE 3

output declined one-half. Increased efficiency in the use of resources on farms accounted for about half of the rise in total agricultural production.

Overall productivity in agriculture did not change much in the early 1900's. It was about the same in 1920 as in 1911. However, productivity went up rapidly in the 1920's and 1930's. Output per unit of input increased at an annual rate of 2.6 percent a year from 1920 to 1939.

Productivity in agriculture declined drastically during the 1940-45 war period when irrigation facilities were damaged and supplies of chemical fertilizer decreased. But agricultural production recovered rapidly after the war. Agricultural output per unit of input returned to the 1939 level in 1952.

Growth in agricultural productivity since 1952 has been remarkable. Agricultural output per unit of input has increased at an annual rate of 2.5 percent a year. The rapid growth of overall productivity since 1952 is especially significant when it is considered that the physical possibilities of bringing additional land under cultivation were very limited and agriculture had to provide employment for an increasing number of workers. In the United States, growth in overall productivity levels in agriculture was relatively slow until after 1930 when the number of workers on farms decreased greatly and mechanization of farming operations took place rapidly (25).

Changes in Individual Inputs

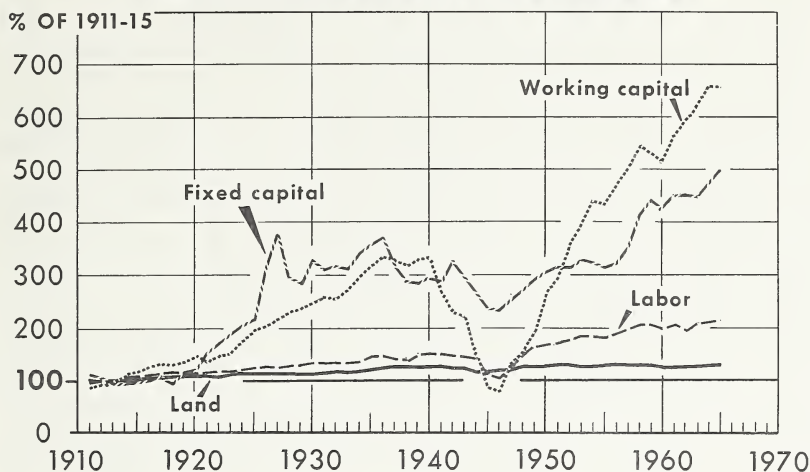
Expansion in total agricultural output in Taiwan has been achieved with a small increase in total cultivated area and a moderate increase in labor input, but it has required large percentage increases in fixed and working capital inputs (fig. 4).

Total cultivated area increased 25 percent from 1911 to 1939 but it has gone up only 4 percentage points since then (fig. 5). Almost all of the land suitable for cultivation had been brought into use by 1939. In recent years, additional land brought into cultivation through irrigation and flood control measures has been offset by the use of agricultural land for urban and industrial purposes. However, total crop area has doubled since 1911 largely due to multiple cropping. Crop area has increased 50 percent since 1940 almost entirely by multiple cropping. Growth of three or four crops a year in many areas has been made possible by irrigation, drainage, and flood control measures. The multiple-cropping ratio increased from 116 percent in 1911-15 to 131 percent in 1941-45, and to 187 percent in 1961-65.

In some areas it still is possible to grow only one crop a year. Sugarcane requires over 1 year from time of planting to time of harvest.

The total number of agricultural workers increased 27 percent from 1911 to 1939, a little less than 1 percent a year. It went up 20 percent from 1945 to 1965, also a little less than 1 percent a year. Increased

AGRICULTURAL INPUTS IN TAIWAN

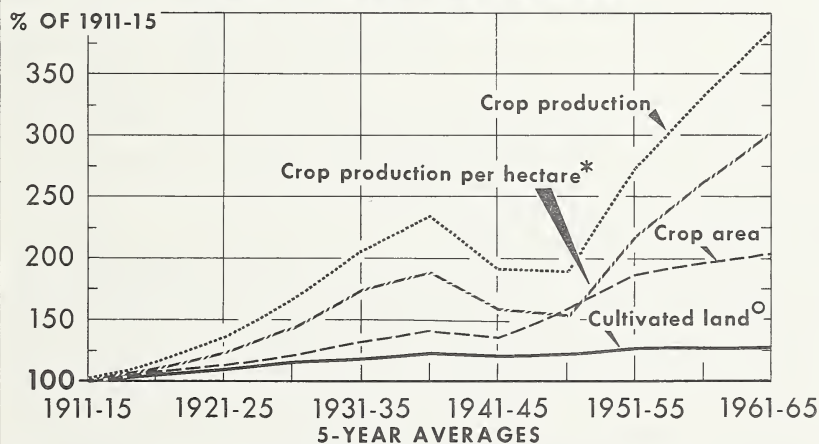


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FIGURE 4

CULTIVATED LAND AND PRODUCTIVITY IN TAIWAN



°CULTIVATED LAND IS TOTAL LAND AREA UNDER CULTIVATION. *CROP PRODUCTION PER HECTARE OF CULTIVATED LAND.

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NEG. ERS 5247-67 (6) ECONOMIC RESEARCH SERVICE

FIGURE 5

multiple cropping has made possible fuller employment of available labor throughout the year. Labor input has increased more than the number of agricultural workers. From 1911 to 1915—1961 to 1965, total labor input measured in man-days doubled at the same time that number of agricultural workers increased 50 percent. Labor input or number of days worked per farmworker increased about one-third.

Working capital inputs (mainly fertilizer, pesticides, and feed) and fixed capital inputs (depreciation of farm buildings, interest on investment in draft animals, and fees for irrigation services) increased greatly. Increased use of capital inputs obviously was strategic in raising overall productivity levels in agriculture. But there has been no large-scale substitution of capital for labor. Capital has been relatively expensive and labor relatively abundant. Although large numbers of rural people migrated to urban areas to find employment, jobs in urban areas were not available for all the additional workers resulting from population growth in rural areas. Under these conditions, employment of additional workers in agriculture was a way of adding to the national product.

Significant changes in the composition of total input have taken place (table 3). The relative importance of labor has not changed much, but capital inputs now account for a much larger share than formerly was the case.

TABLE 3.—*Percentage distribution of input categories in selected periods*

Input category	1911-15	1936-40	1961-65
	Percent	Percent	Percent
Land.....	63	52	41
Labor.....	26	25	27
Working capital.....	9	19	27
Fixed capital.....	2	4	5
Total.....	100	100	100

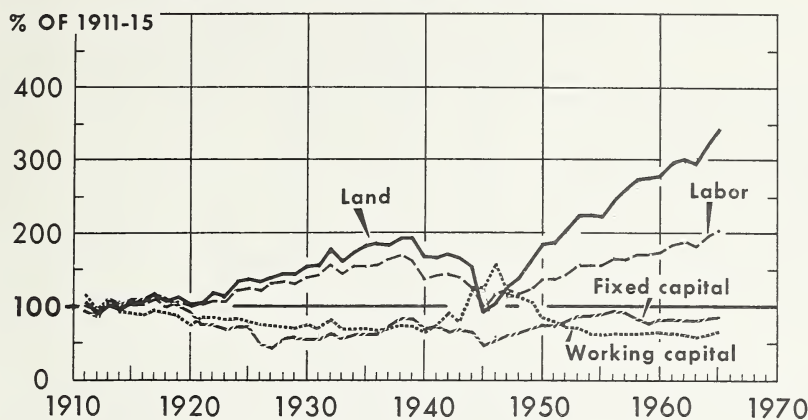
Source: Rural Economics Division, JCRR.

Productivity of Individual Inputs

Agricultural output per hectare of land averaged 3.2 times as high in 1961-65 as in 1911-15 (fig. 6). This increase resulted from increased multiple cropping as well as from higher yields per hectare of crops grown. Growth in productivity per hectare has been especially rapid in the last 15 years. During 1910-39, agricultural output per hectare increased 2.4 percent a year. Output per hectare nearly recovered to the 1939 level in 1951. Since 1951, agricultural output per hectare has gone up 4.4 percent a year.

Growth in labor productivity has been less spectacular but nevertheless significant. Agricultural output per worker averaged 2.5 times as high in 1961-65 as in 1911-15. Growth in labor productivity was

AGRICULTURAL OUTPUT PER UNIT OF INPUT IN TAIWAN



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FIGURE 6

especially rapid during the 1920's and 1930's. Because the number of agricultural workers increased greatly in the postwar period, not until 1956 did agricultural output per worker recover to the prewar record achieved in 1938. However, agricultural output per worker has gone up about 30 percent since 1956.

Diversification of Production

Crop production in Taiwan has been diversified to take advantage of opportunities to grow more crops during the winter and thereby utilize available land, water, and labor resources more fully. Increases in acreages of vegetables, peanuts, soybeans, tobacco, and citrus fruits have been especially large (table 4). The acreage in rice increased, but it decreased in relative importance. The acreage in sugarcane declined substantially since 1939. Economic returns from sugarcane have declined together with lower prices for sugar on the world market. Many farmers have found it profitable to grow vegetables and other crops in place of sugarcane.

Expansion of swine, poultry, and egg production has been encouraged to provide additional protein food. However, shortages of protein feeds limit production of these products. Sweet potatoes are grown mainly to provide feed for swine. In recent years, imports of soybeans and feed grains have been increased to provide more protein feed for swine and poultry production.

TABLE 4.—*Planted area of major crops, Taiwan, selected periods*

Item	1911-15 average	1936-40 average	1961-65 average	Percentage distribution		
				1911-15	1936-40	1961-65
		<i>Thousand Hectares</i>		<i>Percent</i>	<i>Percent</i>	<i>Percent</i>
Rice-----	489	646	772	61	56	47
Sweet potatoes-----	111	135	237	14	11	14
Sugarcane-----	79	141	100	10	12	6
Tea-----	35	45	40	4	4	2
Peanuts-----	19	31	99	2	3	6
Soybeans-----	18	6	55	2	1	3
Wheat-----	6	3	16	1	(1)	1
Jute-----	2	11	9	(1)	1	1
Bananas-----	2	20	25	(1)	2	2
Citrus-----	1	5	17	(1)	(1)	1
Pineapples-----	1	9	13	(1)	1	1
Vegetables-----		41	99	-----	4	6
Others-----	43	46	156	5	4	10
Total crop area----	806	1, 139	1, 638	100	100	100
Total cultivated area----	692	856	878	-----	-----	-----
Multiple-cropping ratio---	116	133	187	-----	-----	-----

¹ Less than 1 percent.

Total crop production increased more rapidly than total livestock production until about 1950 (table 5). However, livestock production has gone up much more rapidly than crop production in the last 15 years.

TABLE 5.—*Index numbers of total agricultural production, crop production and livestock production, Taiwan, selected years*

Years	Total agricultural production	Crop production	Livestock production
	<i>Percent</i>	<i>Percent</i>	<i>Percent</i>
1911-15.....	100	100	100
1936-40.....	230	234	198
1951-55.....	270	273	251
1961-65.....	396	386	459

Sources of Increased Crop Production

Expansion in crop production has come from two sources: Increased cultivated area and increased crop production per hectare of cultivated area. Increases in crop production per hectare of cultivated area also have come from two sources: Increased multiple cropping and increased crop production per hectare of crop area. The relative importance of these different sources has changed over time.

From 1911-15 to 1936-40, expansion in cultivated land accounted for about one-fourth and increased crop production per hectare of cultivated land for about three-fourths of the expansion in total crop

production (table 6). However, from 1951-55 to 1961-65, increased production per cultivated hectare accounted for nearly all of the expansion in crop production.

TABLE 6.—*Annual growth rates in crop production, cultivated land, crop area, production per hectare, and multiple cropping in Taiwan, 1911-15 to 1936-40 and 1951-55 to 1961-65*¹

Items	1911-15 to 1936-40	1951-55 to 1961-65
	Percent	Percent
Crop production-----	3. 5	3. 5
Cultivated land-----	. 9	(²)
Crop production per hectare of cultivated land-----	2. 6	3. 5
Crop area-----	1. 4	. 9
Crop production per hectare of crop area-----	2. 1	2. 7
Multiple-cropping ratio-----	. 5	. 8

¹ Growth rate in cultivated land plus growth rate in crop production per hectare of cultivated land equals growth rate in crop production, and growth rate in crop production per hectare of cropland plus growth in multiple-cropping ratio equals growth rate in crop production per hectare of cultivated land.

² Less than 0.1 percent.

Higher yields per hectare of crop area have been more important than increased multiple cropping as a source of increased crop production per cultivated hectare. In the periods 1911-15 to 1936-40 and 1951-55 to 1961-65, increased crop production per hectare of crop area accounted for about 80 percent and increased multiple cropping for about 20 percent of the increase in crop production per hectare of cultivated land.

The growth in crop production per hectare of crop area is most remarkable. It has involved shifts to crops that mature in a short time and that have a high value per hectare planted. Shifts in crop pattern to include more vegetables and other high-value crops have contributed to increased crop production per hectare of crop area.

Food Consumption and Income

Growth in agricultural output has been large enough to supply the demands for food resulting from rapid population growth and rising incomes and also to supply large amounts of farm products for export. Available data indicate that food consumption per capita may have increased about 25 percent from the early 1900's to the late 1920's and early 1930's as diets were improved to include more fruits, vegetables, and livestock products. However, in the late 1930's and early 1940's food consumption per capita declined to about the level prevailing in 1910-20.

Food consumption levels were depressed during the war years, but recovered quickly after the war. In 1950, food consumption per capita exceeded all previous levels.

Rapid population and income growth since 1950 have caused total food consumption to go up greatly. During 1951-65, total population increased 60 percent and per capita income nearly 80 percent. Per capita food consumption went up about one-fourth and total food consumption nearly doubled. The percentage increases in per capita income and food consumption suggest that income elasticity of demand for food was only about 0.3. This relatively low estimate may be explained by the fact that people generally were consuming fairly adequate diets from a nutritional standpoint in the early 1950's and chose to use their additional income to increase their consumption of clothing, housing, and other items with which they were less adequately supplied.

Expenditures for food as a share of national income and total private expenditures have decreased gradually, as would be expected with rising incomes. Food consumption expenditures accounted for 46 percent of national income in 1951, compared with 38 percent in 1965. They accounted for 56 percent of total private expenditures in 1951 compared with 48 percent in 1965.

People in Taiwan have relatively good diets. For example, per capita consumption of meat averaged 19 kilograms in Taiwan, compared with only 3 kilograms in Japan in 1958. Per capita consumption of fish, fruit, and vegetables averaged about as high in Taiwan as in Japan, but consumption of dairy products averaged much lower in Taiwan than it does in Japan.

Foreign Agricultural Trade

Foreign agricultural trade has been important to Taiwan's economy for many years. During Japanese occupation, exports of rice, sugar, bananas, and other crops were very high. Rice exports reached a record high level of 727,000 metric tons in 1934 when 56 percent of total rice production was exported. Sugar exports reached a record high of 1,315,000 metric tons in 1939 when about 90 percent of the sugar produced was exported. Overall food exports were equivalent to about 45 percent of total food production in 1935-39, compared with 18 percent in 1911-15.

Because of large reductions in exports of sugar and rice, the total volume of food exports of Taiwan averaged much lower in 1961-65 than in 1935-39 (table 7). Expansion in domestic consumption of rice caused by rapid population growth and higher per capita consumption levels has meant that less rice is available for export. Overall food exports were equivalent to about 12 percent of total food production in 1961-65 (table 7).

Imports of wheat and soybeans have increased greatly. In 1965, Taiwan imported over 300,000 metric tons of wheat. Soybeans provide vegetable oils for human consumption and protein feed for expanding swine and poultry production. Overall food imports were equivalent

TABLE 7.—*Changes in total food production, exports, imports, and consumption, Taiwan, 1911-15 to 1935-39 and 1961-65*

Item	Percentage of total food production			Index numbers, 1911-15=100		
	1911-15	1935-39	1961-65	1911-15	1935-39	1961-65
Food production.....	100	100	100	100	245	413
Food exports.....	18	45	12	100	622	251
Food imports.....	4	4	13	100	221	1,359
Seed, feed, stocks, etc.....	10	8	12	100	166	467
Food consumption.....	76	51	89	100	165	485
Total population.....				100	161	341
Per capita food consumption.....				100	103	142

Source: Preliminary estimates made by Rural Economics Division, JCRR.

to 13 percent of total food production in 1961-65, compared with only 4 percent in 1911-15 and 1935-39.

Exports have been diversified in recent years to include more fruit, vegetables, and forestry products (table 8). Mushrooms, canned asparagus, and plywood are new export products that have become important earners of foreign exchange. Less emphasis now is placed on sugar exports because of low and variable prices for sugar in world markets. A large share of the agricultural exports is processed

TABLE 8.—*Value of foreign trade of Taiwan, selected years*

Item	1955	1960	1965
Exports:	<i>Million U.S. dollars</i>		
Sugar.....	68	74	68
Rice.....	33	4	43
Canned pineapple.....	6	8	19
Tea.....	6	6	10
Bananas.....	4	7	55
Canned mushrooms.....			21
Forest products.....	1	6	44
Other agricultural products.....	6	15	51
Total agricultural.....	124	123	311
Nonagricultural products.....	9	50	177
Total exports.....	133	173	488
Imports:			
Wheat and other cereals.....	13	21	36
Soybeans and peas.....	13	17	19
Raw cotton.....	20	20	39
Other agricultural products.....	18	20	46
Total agricultural.....	64	78	140
Nonagricultural products.....	126	174	415
Total imports.....	190	252	555

Source: Data compiled by Rural Economics Division, JCRR.

in Taiwan and thereby increased in value. Consequently, the current value of agricultural exports including processed products still exceeds the total value of agricultural imports—by \$171 million in 1965.

Exports of nonagricultural products have gone up greatly with industrial development in the last few years. However, agricultural commodities, including processed items, account for over 60 percent of the total value of all exports (table 8).

U.S. Agricultural Commodity Aid Programs

During 1951–65, Taiwan received \$389 million of surplus agricultural commodities from the United States under Public Law 480 programs. The commodities imported under these programs were mainly wheat, soybeans, cotton, and milk powder. The total value of these imports was relatively large compared with domestic agricultural production. For example, in 1963 their value was equivalent to about 15 percent of the total value of domestic agricultural production. Percentages for most other years were smaller. Agricultural commodity aid accounted for 23 percent of all economic aid to Taiwan in 1951–65. These large imports were distributed in such a way as not to interfere with economic incentives of farmers to expand agricultural production. A large part of the funds obtained from the sale of these products in Taiwan has been used to finance agricultural development projects. Public Law 480 programs in Taiwan have helped bring about economic development in Taiwan and at the same time have helped create commercial markets for U.S. farm products.

CHAPTER IV.—AGRICULTURE'S CONTRIBUTIONS TO ECONOMIC GROWTH

Agriculture plays an important role in economic development of a nation in several different ways, especially during the early stages when agriculture accounts for a large share of total employment and national income (19). Agriculture contributes to economic development by providing food and fiber for a growing population and also agricultural products for export to earn foreign exchange. It usually is called upon to provide workers for nonfarm employment and capital to build up urban industries. As agriculture includes a large share of total population, it is a major market for industrial goods.

Growth in agricultural productivity in Taiwan has contributed to national economic growth in two major ways. It has made possible net transfers of capital and labor from agriculture to other sectors of the economy. These transfers would not have been possible without reducing consumption levels of farmpeople if overall productivity in agriculture had not increased (8).

Net Transfer of Capital

T. H. Lee (23) has estimated the flows of products and funds out of agriculture to other sectors of Taiwan's economy and from other sectors into agriculture. The data used in preparing this section are from his study.

The total value of the outflow of products (table 9) from the agricultural sector for use in nonagricultural production (primarily processing or manufacturing), for exporting directly, and for consumption in nonfarm households has exceeded the total value of the inflow of intermediate goods, capital goods, and consumption goods that went into the agricultural sector in all years for which estimates are available. For example, the net outflow, measured in current Taiwan dollars, was NT \$55 million in 1920, NT \$102 million in 1940, and NT \$1,931 million in 1960 (table 9). Agriculture has depended upon the purchase of capital goods from nonagricultural sources. Without these capital goods, productivity in agriculture could not have increased as much as it did.

Funds flow out of agriculture by payments of farmers for rent, interest, taxes and fees, and savings deposits made by farmers through financial institutions. Funds flow into agriculture by public invest-

TABLE 9.—*Net flow of capital between agriculture and other sectors, Taiwan, selected years*

Item	1920	1940	1960
<i>Million current NT\$</i>			
1. Total agricultural production.....	229	599	22,898
2. Total outflow of agricultural products.....	132	416	13,460
Agricultural products.....	67	215	6,525
Nonfarm household.....	45	105	6,467
Exported directly.....	20	96	468
3. Total inflow of nonagricultural goods.....	77	314	11,529
Intermediate goods.....	22	99	3,803
Capital goods.....	2	13	1,057
Consumer goods.....	53	202	6,669
4. Net outflow (2 minus 3).....	55	102	1,931
5. Gross outflow of funds.....	67	164	3,632
Land rent and interest.....	54	120	1,010
Taxes and fees.....	12	39	2,102
Financial institutions.....	1	5	520
6. Gross inflow of funds.....	13	62	1,701
Public investment and subsidy.....	3	7	187
Investment by nonagricultural producers.....	1	10	-----
Income from nonagricultural production.....	9	45	1,514
7. Net outflow of capital (5 minus 6).....	55	102	1,931
8. Net real outflow of capital ¹	64	51	100

¹ Values in 1936-37 constant prices computed by deducting deflated value of total outflow of agricultural products from deflated value of inflow of non-agricultural goods.

Source: Lee (23).

ments and subsidies, investment by nonagricultural producers, and income earned by farmpeople from nonagricultural sources.

It is especially important to observe the net real outflow of capital from agriculture as this is the amount available from agriculture for building up industry and other forms of production in the nonagricultural sectors. The amounts for selected years in millions of 1935-37 Taiwan dollars were as follows:

<i>Million NT\$</i>	<i>Million NT\$</i>
1911----- 47	1935----- 68
1915----- 63	1940----- 51
1920----- 64	1950----- 68
1925----- 53	1955----- 97
1930----- 73	1960----- 100

The amounts have increased together with the growth in agricultural productivity. It is evident that a large part of the economic surplus created by growth in agricultural productivity has been transferred out of the agricultural sector and used for development of the nonagricultural sectors. However, a part has been retained in agriculture for consumption and further production.

Net Transfer of Labor

The rise in productivity of agricultural workers in Taiwan has made possible the release of many farmpeople for work in other occupations. Of course, many farmpeople have moved to urban areas because of pressure of population on the land, relatively low incomes from farmwork, and opportunities for earning higher incomes in urban areas. Nevertheless, the proportion of the total labor force that is engaged in agriculture could not have declined if output per worker in agriculture had not increased.

Precise data on net migration from agriculture to nonagricultural sectors are not available. However, estimates can be made if it is assumed that population growth has been about the same for the agricultural population as for the nonagricultural population. A study of rural labor by Tsui and Lin (36) indicates that natural population growth rates were about the same in cities as in townships (rural areas) during 1953-62.

The net migration of people from agriculture to nonagricultural sectors during 1910-40 was estimated as equal to nearly 30 percent of the nonagricultural population in 1940 (table 10). On the average, about 30,000 farmpeople moved to urban areas each year during 1910-40. Population growth trends in 1945-50 were affected by migration from mainland China. The long-term decline in agriculture's share of total population was affected by this external migration. However, estimates indicate that net migration from agriculture to nonagricultural sectors was equal to nearly 15 percent of the nonagricultural

TABLE 10.—*Estimates of net migration of people from agriculture to nonagricultural sectors, 1910 to 1940 and 1950 to 1965*¹

Items	Agriculture	Nonagricultural	Total
<i>Thousand</i>			
1910 to 1940:			
1910 actual-----	2, 087	1, 212	3, 299
1940 actual-----	2, 984	3, 093	6, 077
1940 with no migration-----	3, 840	2, 137	6, 077
Net migration-----	- 856	+ 856	-----
1950 to 1965:			
1950 actual-----	3, 998	3, 556	7, 554
1965 actual-----	5, 739	6, 889	12, 628
1965 with no migration-----	6, 692	5, 936	12, 628
Net migration-----	- 953	+ 953	-----

¹ Estimates assume the same natural population growth in nonagricultural sectors as in agriculture and no external migration.

population in 1965. In 1950-65, about 60,000 farmpeople moved to urban areas each year. Because of migration in earlier years, the proportion of the nonagricultural population in 1965 that moved from rural areas to cities was much higher than 15 percent.

Agriculture makes an important contribution to growth of non-agricultural sectors through migration. People who migrate from farms to cities have been reared and educated in rural areas. Thus capital invested in people is transferred from agriculture to non-agricultural sectors.

There has been much discussion of labor surplus in agriculture in developing countries. A study by Liu and Swanson (24) concludes that labor used in agriculture in Taiwan has a positive marginal productivity. Although available labor in agriculture is not fully employed throughout the year, labor shortages exist during peak labor seasons when rice is planted and harvested. Gillin (10) points out in his study of Hsin Hsing near Lukong that many people who have moved to cities return to the village to help with rice harvests and other peak-of-season labor.

Economic Transformation

As in other developing countries where per capita incomes have increased, demand for food and agricultural raw materials for processing has not increased as much as demand for industrial products and services. This has meant that agriculture has declined in relative importance as a source of national income and as an employer of resources, especially labor.

Economic transformation of Taiwan's economy may be observed by referring to population growth data for the agricultural and nonagricultural sectors (fig. 7). From 1910 to 1940, total population grew at

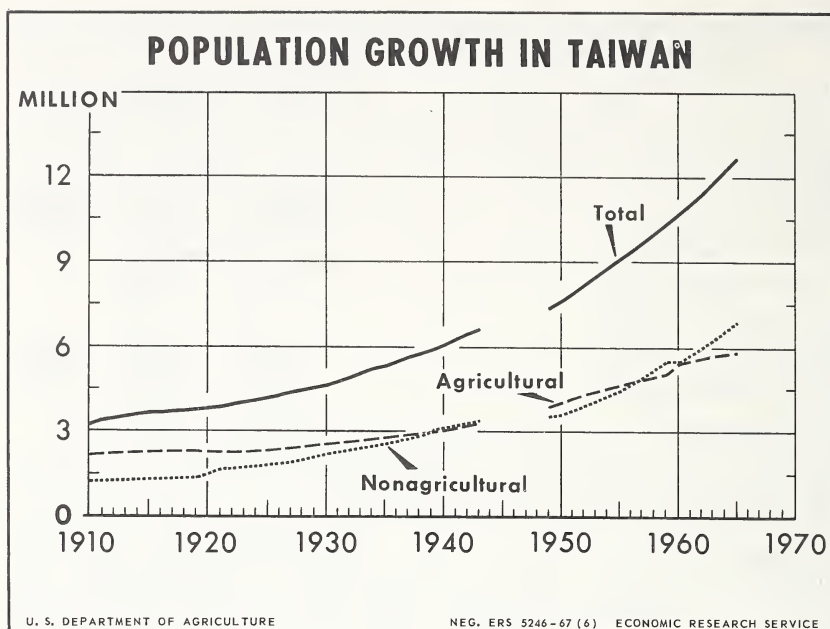


FIGURE 7

the rate of 2.2 percent a year. Agricultural population growth was 1.4 percent a year. Economic transformation took place as indicated by the fact that agriculture accounted for only 49 percent of the total population in 1940 compared with 63 percent in 1910.

With the large migration from mainland China after 1945, agricultural as well as total population increased rapidly. In 1950, agricultural population accounted for 53 percent of total population but the proportion decreased to 46 percent in 1965. During 1950-65, the total population increased 3.5 percent a year; agricultural population, 2.5 percent; and nonagricultural, 4.4 percent. Although economic transformation and industrialization of the economy have taken place rapidly, high population growth and inability to increase nonfarm employment opportunities at a more rapid rate have limited the movement of workers from farms to cities. Population growth rates are beginning to decline, but the total labor force in agriculture will probably continue to increase for the next few years.

From 1951 to 1962, per capita incomes of labor in agriculture averaged only one-fourth to one-half as high as they did for workers employed in industry and commerce according to a study by Tsui and Lin (36).

Net domestic product originating in agriculture decreased from 35 percent of gross national product in 1952 to 27 percent in 1965. But, because a large part of industry, commerce, and transportation

depends upon agricultural raw materials or is concerned with supplying materials and services for farm production, agriculture continues to be the major sector in the total economy.

CHAPTER V.—TECHNOLOGICAL INNOVATIONS

It has long been recognized in Taiwan that technological innovations that increase production per hectare and per worker are essential for agricultural progress. Since the occupation, much emphasis has been placed on the introduction of promising varieties of plants and breeds of animals from abroad and on breeding them to develop more productive varieties that are adapted to Taiwan conditions. Research has been done on disease and insect control, soil fertility improvement, effective irrigation methods, and better quality farm products for export as well as home use. Extension workers have been the main channel for disseminating technological innovations to farmers.

Inputs for Research and Extension

Taiwan has well-developed systems for carrying out agricultural research, education, and extension work. Inputs for agricultural research appear large, compared with those of most developing countries. Emphasis has been placed on finding practical solutions to problems of farm production and marketing that will increase agricultural productivity.

In 1963, there was a technical staff of 1,096 in the 34 agricultural research and experiment stations and institutes. About 70 percent were graduates of senior agriculture vocational schools and 30 percent were college graduates. Only about 20 had M.S. or Ph. D. degrees (35). Other public enterprises such as the Taiwan Sugar Corporation, the Taiwan Tobacco and Wine Monopoly Bureau, the Taiwan Pineapple Corporation, and the fruit marketing cooperatives also have research stations. Altogether there are about 400 college graduates engaged in agricultural research in Taiwan. This means that there is one college-trained agricultural research worker for each 2,100 farmers and each NT\$80 million (US\$2 million) of agricultural production. Counting all research workers, there is one agricultural research worker for approximately each 800 farmers and NT\$26 million of agricultural production.

Agricultural extension work is conducted primarily by vocational agriculture school graduates. In 1966, there were 29 college graduates and 957 vocational school graduates engaged in agricultural extension work at provincial, county, and township levels. In addition, there were seven college graduates and 257 vocational school graduates engaged in home economics extension work. These numbers do not include those employed by the Taiwan Sugar Corporation, the Taiwan Tobacco and Wine Monopoly Bureau, and other organizations.

However, there is at the township level only one extension worker for about each 1,000 farmers.

Administrative Organization of Research and Education

Agricultural education, research, and extension work in Taiwan are carried out by separate administrative organizations, but this apparently has not limited their effectiveness.

All educational institutions, including those for agriculture, are under the direction of the Ministry of Education. Enrollment in agricultural colleges and schools in 1962 was as follows:

4-year Colleges of Agriculture:	
National Taiwan University, College of Agriculture-----	1, 187
Provincial Chung Hsing University, College of Agriculture--	1, 414
Total -----	2, 601
3-year Agricultural Institute:	
Pingtung Agricultural Institute-----	521
Vocational Agriculture Schools:	
Senior vocational agriculture programs-----	12, 093
Junior vocational agriculture programs-----	13, 257
Total -----	25, 350
All students-----	28, 472

Vocational agriculture school graduates provide staff members for carrying out agricultural research on district agricultural improvement stations and extension work of farmers' associations. They also provide trained personnel for credit and economic (buying and selling) departments of farmers' associations and for farmer cooperatives.

There are 41 vocational agriculture schools. Junior schools consist of three grades comparable to grades 7, 8, and 9 in U.S. schools. Senior schools have three grades comparable to grades 10, 11, and 12 in U.S. schools. The numbers shown above include those attending 5-year vocational agriculture schools. According to Meaders (26), 53 percent of the graduates of these schools in 1950, 1955, and 1959, excluding those in the military service or enrolled in higher level schools, were employed in occupations relating to agriculture or in farming. Nearly half were employed in nonagricultural occupations. About 30 percent of the vocational agricultural school graduates interviewed by Meaders were engaged in farming as active farm operators, farm managers, or workers. However, the fact that nearly half of the vocational agriculture school graduates were not associated with agriculture-related industries suggests that more people are trained for agricultural occupations than can effectively be used in agriculture.

Enrollment in agricultural colleges in 1962 was large enough to pro-

vide about 600 graduates a year or about one for each 1,500 farm households. This is a large number compared with that in most developing countries. It is much more than needed to staff available positions in agricultural research, education, and extension organizations. Many agricultural college graduates are employed in business organizations associated with agriculture.

The Provincial Department of Agriculture and Forestry has major responsibility for agricultural research. It has under its jurisdiction the following:

1. Agricultural Research Institute. It has five departments concerned with agronomy, horticulture, agricultural chemistry, plant pathology, and applied zoology, and five substations concerned with horticulture, tropical horticulture, rice and sweet potatoes, cotton and jute, and tea.

2. Livestock Research Institute.

3. Seven Agricultural Improvement Stations. They conduct research on problems of a regional nature, help multiply new seeds, and give demonstrations and technical assistance in extension work.

4. Seed and Seedling Multiplication Farm.

5. Veterinary Serum and Vaccine Laboratory.

6. Forestry Research Institute with six branch stations.

7. Fishery Research Institute with four branch stations.

In addition to these organizations, the Sugar Research Institute of the Taiwan Sugar Corporation, the Tobacco Research Institute of the Provincial Tobacco and Wine Monopoly Bureau, and the Pineapple Experimental Station of the Taiwan Pineapple Corporation carry out applied research. Some agricultural research also is conducted by the College of Agriculture of National Taiwan University, Provincial Chung Hsing University, and the Botanical Research Institute of Academia Sinica which does basic research on rice.

Nearly all of these educational and research institutes and organizations were originally established during the Japanese administration, but their work has expanded in recent years. During the Japanese occupation, Taiwanese or Chinese usually were not eligible for higher level education in agriculture or other fields except medicine. The few exceptions to this rule were individuals who adopted Japanese names. Agricultural research was under the direction of Japanese agricultural scientists; most of them returned to Japan after 1945. Consequently, Taiwan was left with few college-trained agriculturalists after the war. Many college-trained agriculturalists came to Taiwan from mainland China in 1945-60; nevertheless, Taiwan was faced with the task of building a trained staff of agricultural scientists. However, there were large numbers of Taiwanese who had vocational training in agriculture.

Agricultural extension work in Taiwan, now known as Cooperative Extension Work in Agriculture and Home Economics, is carried out

by provincial, county, and township farmers' associations under sponsorship of the Provincial Department of Agriculture and Forestry and county governments. In each township, there now are agricultural extension advisory committees composed of representatives from the township government office, the township farmers' association, the vocational agricultural school in the area, and two or three local farmers. These committees plan and coordinate extension activities.

Elementary education now is free and compulsory. The 1959 census reported that 97 percent of all primary-school-age children are attending school. However, only about half of Taiwan's adult farmpeople can read and write. The percentage was lower in earlier years, so dissemination of knowledge about improved farming methods could not be based only on reading materials. Field demonstrations to show the effects of improved seeds, fertilizer, pest and disease control, and other improved farming practices have been used widely.

Farmers' Associations and Cooperatives

As farmers' associations have been the major organizational unit through which agricultural extension work has been carried out, it is useful at this point to know more about their origin and functions. This brief account relies heavily on a report by Kwoh (22).

In 1966, there were 364 farmers' associations (including the provincial farmers' association in Taichung), 22 county and city associations, and 341 township associations. Under the township farmers' associations, there were 4,872 small agricultural units located in villages. Farmer members elect representatives at meetings of the small agricultural units and these representatives elect directors and supervisors to boards of directors and boards of supervisors of the township farmers' associations. Township association representatives elect directors and supervisors of the county farmers' associations. Representatives of the county associations in turn elect directors and supervisors of the Provincial Farmers' Association. Policymaking and supervision of farmers' associations are controlled by representatives of the 830,000 farm members.

Farmers' associations have two types of members: Regular and associate or farmer and nonfarmer members. Regular or farmer members must obtain at least half of their income from farming. Others who reside in the area can become associate members. An associate member does not have the right to elect but he may be elected a supervisor. However, the number of supervisors thus elected is limited to one-third of the total number of supervisors. Boards of supervisors review the financial accounts of an association while boards of directors are responsible for policy decisions and operations, including the hiring of a general manager.

Farmers' associations are multipurpose and have three major sections: (1) An economic section for marketing farm products and

for purchasing farm supplies and consumption goods for sale to members, (2) a credit section for receiving deposits of savings and making loans to members, and (3) an agricultural extension section for conducting advisory and training services. In addition, associations have accounting and administrative sections. Some carry out insurance programs for swine and cattle.

Farmers' associations are the organizational units through which Government agencies carry out programs with farmers (fig. 8). The Provincial Food Bureau, for example, through farmers' associations carries out its fertilizer-barter operations, distributes pesticides and other supplies, and collects land taxes. Functions of the Provincial Food Bureau will be discussed in greater detail later.

Taiwan has six fruit marketing cooperatives combined under one federation located in Taipei. Two specialize in marketing bananas, and four market citrus and other fruits and vegetables. They render technical services for improving the quality of fruit through pest control and distribution of better varieties.

Taiwan also has 68 fishermen's associations, one at the provincial

RELATIONSHIP BETWEEN GOVERNMENT AGENCIES AND FARMERS' ASSOCIATIONS

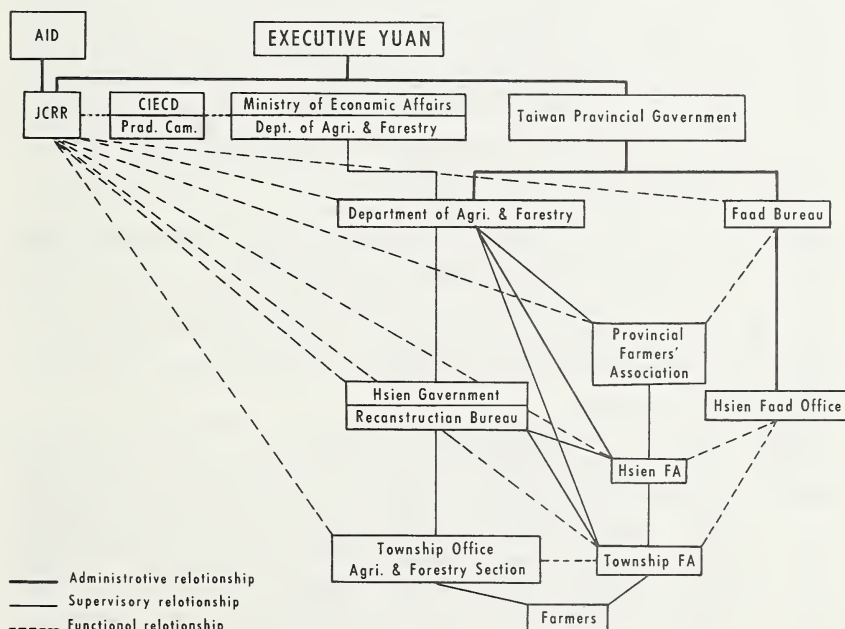


FIGURE 8

level and 67 at a city or township level, concerned with improving the marketing of fish, furnishing supplies, and conducting educational work.

The present federated system of farmers' associations has resulted from the amalgamation of many rural organizations formed in Taiwan since 1900. Before 1945, there were two major types: (1) Associations for agricultural extension work including farmers' associations, forestry association, livestock associations, and small agricultural units, (2) cooperatives for providing credit and purchasing, marketing, utilization, and warehousing services.

According to Kwoh, (21), the first farmers' associations established in the early 1900's were organized voluntarily by farmers to protect themselves from landlords and to seek land rent reduction. There were 16 in 1908. The importance of these associations was recognized and they were brought under Government control. The number was gradually reduced to eight in 1927, with one in each of the then eight counties or prefectures. In 1938 the Taiwan Farmers' Association was formed as an overall organization. Branch offices were established in each township, which served several small agricultural units to assist in extension work. Farmers' associations were given special powers to compel all landowners and operators to become members and pay membership dues. In addition, the Government collected land taxes and made grants for support of associations.

The first small agricultural unit was organized in 1906 for managing rice nurseries cooperatively. By 1944, there were 4,891 of these units. They also were concerned with protection of plants and animals from diseases and insects and in some instances tried to settle disputes between landlords and tenant workers.

Cooperative organizations enjoyed a steady growth from 16 in 1913 to 251 in 1920 and over 500 in 1940. In 1942, the Taiwan Federation of Cooperatives was established. Cooperatives were mainly concerned with the provision of credit in the beginning, but they gradually become multipurpose organizations engaged in purchasing, marketing, warehousing, rice milling, and distribution of fertilizer and consumption goods.

There was much overlapping of functions and friction among the different rural organizations. Therefore the Japanese Government decided in 1942 to combine all farm associations and cooperatives into a unified agricultural association set up at three levels: Island-wide, county or prefecture, and township. The small agricultural units came under the township associations. Nearly all farmers were compelled to become members and pay membership fees. To assure control and carrying out of Government policies required under the stress of wartime conditions, all associations were headed by Government authorities.

The unified organization was retained temporarily after the end of the war in 1945, but in 1946 it was decided to resplit the organization into two parts with farmers' associations having responsibility for extension services and the cooperatives for credit, marketing, and other economic services. However, this organizational arrangement did not operate effectively and it was decided to amalgamate the two organizations into a unified system of farmers' association at the end of 1949. However, associations came to be dominated by nonfarmer members. In 1953, extensive reorganization providing for democratic control of associations by bona fide farmers was carried out.

Major Technological Advances

Technological advances in crop production in Taiwan are shown by increases in crop yields (table 11). Yields per hectare of rice, sugarcane, peanuts, soybeans, pineapple, and citrus averaged more than twice as large in 1961-65 as they did in 1911-15. Yields of nearly all crops show spectacular increases since 1936-40.

In reviewing these yield changes, it must be remembered that multiple cropping has greatly increased. Many farmers adjust the planting periods or plant early maturing varieties in order to grow more crops per year and thereby maximize the total value of crops produced per hectare in a year. Farmers often interplant tobacco, vegetables, and sugarcane in ricefields 10 to 14 days before rice is harvested. In this way, land is utilized more fully and total crop production is increased although yields of individual crops may not be as high as they would be if grown alone.

Total crop production per hectare of cultivated area has gone up more than yields of individual crops (fig. 5). For example, crop pro-

TABLE 11.—*Crop yields per hectare of planted area, Taiwan, 5-year averages for selected periods*

Crop	1911-15 average	1936-40 average	1961-65 average	Change, 1911-15 to 1961-65	
				Increase in yields	Compound annual growth rate
Kilograms per hectare				Percent	Percent
Rice.....	1, 347	2, 020	2, 804	108	1. 8
Sugarcane.....	24, 421	68, 380	74, 586	205	2. 8
Sweet potates.....	6, 842	11, 909	12, 700	90	1. 6
Peanuts.....	529	954	1, 080	104	1. 8
Soybeans.....	527	629	1, 038	97	1. 7
Wheat.....	767	999	1, 926	151	2. 3
Tea.....	¹ 359	296	523	46	1. 0
Tobacco.....	1, 312	1, 822	2, 093	60	1. 2
Bananas.....	8, 677	9, 550	12, 546	43	. 9
Pineapples.....	8, 088	13, 177	19, 199	137	2. 2
Citrus.....	3, 313	6, 135	7, 122	115	1. 9
Vegetables.....	¹ 8, 830	9, 887	9, 082	3	-----

¹ 1916-20 averages.

duction per hectare averaged 1.9 times as much in 1936-40 as it did in 1911-15. It averaged 3 times as much in 1961-65 as it did in 1911-15. The 60-percent increase in crop production per hectare since 1936-40 is especially significant as this period included the years of recovery after the war. Most of the yield increases in the postwar period were achieved after 1950.

A combination or package of improved farming practices is responsible for yield increases. It includes better crop varieties, increased use and timely application of chemical fertilizer and pesticides, rotational irrigation to maximize use of available water supplies, and better cultural practices with respect to spacing of plants, weed control, and others.

Livestock productivity per animal unit has been increased by the introduction of improved breeds adapted for Taiwan conditions, better feeding practices, and increased attention to disease control and health of animals. Feed rations have been improved to include more protein meals to achieve earlier maturity in raising hogs and higher rates of lay in poultry.

Variety improvements of rice and sugarcane have been especially important. Hsieh and Lee (15) report that 1,197 different varieties of rice, mostly of the indica type, were grown in Taiwan in the early 1900's. The Japanese Government issued orders restricting the number of varieties that could be grown, and only 390 varieties were grown in 1920. Many japonica varieties of Japanese rice were introduced. Selections of adaptable japonica varieties were made and these were crossed with indica varieties. The ponlai rice varieties were made available in 1926. These superior ponlai rice varieties gradually were spread from higher to lower elevations and from north to south. Not only did ponlai rice replace the native varieties but the number of ponlai varieties gradually was reduced and only the best varieties were kept in production. In recent years, superior ponlai varieties resulting from experimental work have largely replaced the old varieties. As native varieties still account for about a third of the rice acreage, superior indica varieties were developed and released. Attention has been given rice varieties adaptable to intensive cropping systems where two crops of rice are grown each year and often interplanted with other crops before harvest.

The Japanese put a high priority on sugarcane variety improvement when Taiwan came under Japanese control in 1895. A diminutive Chinese cane called Tekcha, believed to have been brought from South China about 1610, was the main variety grown. A variety called Rose Bamboo was introduced from Hawaii in 1896 and released for general planting in 1902. It was superior to Tekcha in yield and sucrose content, but it was highly susceptible to wind damage by typhoons, so new hardy varieties were introduced from Java and they became

common in the 1920's and 1930's. Superior local varieties developed in Taiwan have become common since the World War II. Also new seed varieties and other breeding materials have been introduced from Natal, South Africa. Attention has been given in recent years to developing varieties that mature in 14 instead of 18 months, as well as to varieties that are disease resistant, hardy enough to withstand wind damage, and have high yields and a high sucrose content.

Variety improvement also has been done for soybeans, wheat, peanuts, and fruits and vegetables. Shen has described these advances in great detail (32).

Agricultural research has been largely applied research focusing on practical problems of farmers. It is significant that some research findings of great economic value have been made by agriculturalists who do not have advanced college degrees. For example, an agricultural vocational school graduate who received a small grant from JCRR for carrying out research on growing asparagus did the pioneering work that revealed how to grow asparagus under tropical conditions. A college graduate who had no advanced degrees carried out the research on how to grow mushrooms successfully on synthetic compost. Exports of these two crops earned \$32 million of foreign exchange in 1965.

Extension of New Technology

Rapid adoption of improved technology on farms may be attributed to a number of conditions:

1. Emphasis on applied research designed to provide findings that meet farmers' needs.
2. The innovating attitude of most Taiwan farmers.
3. Wide use of field demonstrations of integrated packages of improved practices.
4. Provision of needed supplies and credit through farmers' associations and other organizations.
5. A family system of farming that creates strong economic incentives for individual farmers to adopt improved practices that increase output.
6. Readily available markets for farm products.

During the Japanese occupation, regulations were put into effect limiting varieties of rice, sugarcane, and other crops that could be planted to those that had superior yield and disease-resistant qualities. Regulations with regard to spacing of plants in ricefields, quantities of fertilizer to be applied, insecticides to be used, and others also were put into effect. Government regulations apparently were effective in achieving improved farming practices.

Since retrocession of Taiwan to the Republic of China, voluntary methods have been relied upon to get farmers to adopt improved technology. As the number of extension workers is small compared

with the number of farmers, many farmer discussion groups have been organized in villages as a means of providing new information to farmers. Extension workers meet with these groups once a month to discuss farm production and marketing problems. Members of discussion groups are relied upon to educate other farmers on new agricultural methods.

Subsidies to pay part or all of the costs of new inputs have been used at times to get new farming practices adopted. For example, when chemical fertilizer first was introduced, by the Japanese, fertilizer was distributed free to farmers for demonstration purposes. Later when farmers observed how much fertilizer increased crop yields, they were required to pay a part of the fertilizer cost, and still later, the full cost.

The dissemination of new technology such as improved seed usually involves several steps. The seed is first developed through plant breeding at experiment stations. Foundation seed then is tested at regional agricultural improvement stations. If the new seed is found superior, it then is propagated by farmers who are certified seed growers. Finally, it is distributed widely through farmers' associations for use by farmers.

The agricultural improvement stations have extension educational as well as research functions. They also report on field conditions with respect to disease and insect infestations and recommend steps that need to be taken to overcome these hazards. They work closely with extension workers employed by farmers' associations in field demonstrations showing how combinations of improved practices can increase crop yields.

In recent years, increased emphasis has been placed on extension programs designed to show how yields of rice and other crops can be stepped up by an integrated package of improved farming practices over a large area of 5 to 15 hectares covering many farms. These demonstrations indicate that rice yields can be increased as much as 30 percent, compared with yields on adjoining farms. Farmers join together in carrying out farming operations, but they retain ownership of their land and of the production from their individual farms. These joint farming operations achieve fuller utilization of land and other resources in addition to higher yields (33).

The integrated package approach also has been widely used to step up efficiency in swine and poultry production. However, this does not involve joint farming operations.

Some Conclusions

Investments and expenditures for research and education in Taiwan have yielded high economic returns. Without these investments and expenditures, agricultural output could not have increased very much. This is also true of investments for irrigation, drainage, and flood

control, and expenditures for fertilizer, pesticides, and other capital items. Taiwan's experience indicates that introduction of high-yielding plants and animals from abroad can be used to raise productivity, although research also is needed to provide improved varieties adapted to local conditions. The Taiwan experience indicates there is no one way to organize agricultural research and extension work that is best for all countries. However, it is essential that research be focused on production and marketing problems at the farm level if it is to yield maximum economic returns. Similarly, when it is demonstrated at the farm level that new technology increases economic return to farmers, it is not difficult to get farmers to adopt the new methods.

CHAPTER VI.—STRUCTURAL ORGANIZATION OF FARMING

Questions often are raised concerning what sizes of farms and systems of land tenure are most conducive to increases in agricultural productivity. Here we are concerned with how sizes of farms and tenure systems affected the adoption of technological innovations, capital formation, savings, and investments in agriculture in Taiwan.

Taiwan is a land of many small owner-operated farms. In 1949, before land reform was carried out, 39 percent of the farmers were tenants and 26 percent were part owners. Nearly half of all cultivated land was operated by tenants or part owners. Large gains in agricultural productivity were achieved before World War II with many small farms and fairly high tenancy. However, large-scale plantation-type farms were important in sugarcane production. Land reform, beginning in 1949, brought about an increase in the number of owner-operated farms, reduction in rents on tenant-operated land, and a more equitable distribution of farm income.

Farm Size and Productivity

Numbers of farms and farm households in Taiwan went up only 7 percent from 1912 to 1940 (table 12). But agricultural population (people living on farms) increased 36 percent and the average number of people per farm household increased from 5.5 to 6.9. Cultivated land area expanded more rapidly than number of farms. Although average size of farm increased very little, from 1.7 hectares in 1912 to 2.00 hectares in 1940, agricultural output per farm increased 116 percent. Agricultural output per hectare of cultivated land increased 86 percent.

Changes since 1940 have been quite different. The total number of farms has doubled and average size of farms has decreased to 1.05 hectares. The number of people per farm household has decreased slightly. Total cultivated land increased only 4 percent as potentials for bringing additional land under cultivation were gradually ex-

TABLE 12.—*Number of farms, cultivated land, land per farm and agricultural output per farm and per hectare, Taiwan, selected years, 1912-65*

Year	Number of farms	Cultivated land	Cultivated land per farm	Agricultural output	
				Per farm	Per hectare
	Thousand	Thousand hectares	Hectares	Percent	Percent
1912-----	401	690	1.72	100	100
1917-----	415	721	1.74	129	128
1922-----	385	751	1.95	149	131
1925-----	394	775	1.97	175	153
1930-----	411	812	1.97	195	170
1935-----	420	831	1.98	233	203
1940-----	430	860	2.00	216	186
1945-----	501	816	1.63	97	102
1950-----	638	871	1.37	162	204
1955-----	733	873	1.19	172	248
1960-----	786	869	1.11	198	308
1965-----	847	890	1.05	231	378

Source: Rural Economics Division, JCRR.

hausted and industrial and urban growth occupied some agricultural land. Agricultural output per farm did not change much, but it is significant that it was maintained in view of the reduction in land area per farm. More intensive use of land brought a doubling in agricultural output per hectare.

Reduction in average size of farm after 1940 resulted from rapid agricultural population growth. Given the large increase in farm population, the only alternative to reduction in sizes of farms would have been larger farms with more families and workers per farm. It should be noted that a larger net migration of farmpeople to non-farm occupations was not an effective alternative, as farmpeople migrated to cities to the extent employment opportunities were available.

The breakup of farms into smaller units apparently was a way of improving incentives to use land more intensively and of obtaining additional agricultural production from available labor. Agricultural output per hectare is much larger on small farms than on large farms in Taiwan. For example, in 1965 agricultural production per hectare as measured by farm receipts averaged twice as large on farms under 0.5 hectare as it did on farms over 2.0 hectares (table 13). Small farms have much higher farm expenses per hectare than do large farms, but small farms also have much higher net incomes per hectare.

On the other hand, farm receipts, expenses, and incomes, of course, average higher on the larger farms. Larger farms and a larger land area per family obviously would be desirable in Taiwan as they would mean larger net incomes per farm family. But they are not real

TABLE 13.—*Farm receipts, expenses, and income per farm and per chia by size of farm, Taiwan, 1965*

Size of farm	Farm receipts		Farm expenses		Net farm income	
	Per farm	Per chia ¹	Per farm	Per chia ¹	Per farm	Per chia ¹
<i>Chia</i> ¹			<i>Thousand NT\$</i>			
Under 0.51-----	28	72	12	32	16	40
0.52-1.03-----	44	57	19	24	25	33
1.04-1.54-----	62	48	26	20	36	28
1.55-2.06-----	78	43	35	19	43	24
Above 2.07-----	112	36	45	14	67	22
All farms-----	60	46	25	19	35	27

¹ A chia is equal to 2.397 acres or 0.9699 hectare.

Source: (9).

alternatives as long as the total farm population continues to increase. In the future, as population growth rates decline, industrial development provides additional employment opportunities in urban areas, and a larger net migration from farms to cities takes place, expansion in sizes of farms may be expected.

With the growth in number of farm units and also with land reform, a large share of the cultivated land is in small size units (table 14). For example, 35 percent of the privately owned land area was in holdings of less than 1 hectare in 1955, compared with 25 percent in 1952. The shift in farm size structure has led to more intensive land use and larger total agricultural production.

Corporation Farms

Taiwan's experience with growing sugarcane on large-scale farms is of special interest. The Taiwan Sugar Corporation (TSC), the largest public enterprise engaged in farming, produces sugarcane on about 40,000 hectares each year. It draws about 30 percent of its cane supply from its own farms and the rest from family farms under contract.

TABLE 14.—*Distribution of privately owned cultivated land by size of holding, Taiwan, 1952 and 1955*

Size of holding	Cultivated land		Percentage distribution	
	1952	1955	1952	1955
<i>Hectares</i>	<i>Thousand hectares</i>	<i>Thousand hectares</i>	<i>Percent</i>	<i>Percent</i>
Below 0.5-----	68	92	10	14
0.5 to 1.0-----	103	146	15	21
1.0 to 3.0-----	227	286	33	42
3.0 to 10.0-----	175	124	26	18
Over 10-----	108	32	16	5
Total-----	681	680	100	100

Reproduced from Tang and Hsieh (34, p. 124).

During the 1945-48 rehabilitation period, sugarcane yields averaged higher on the family farms than on the corporation farms (32, p. 342). However, in 1949-55, when TSC concentrated its efforts on improving techniques on its own farms, yields were higher on the corporation farms. But yields were again generally higher on family farms than on corporation farms in 1956-60 when TSC provided extension and other services to family farms. Higher yields on family farms may be attributed to the fact that workers on these farms have an economic interest in achieving high yields and therefore work harder and more carefully than hired workers on corporation farms. Moreover, most family farms produce hogs and poultry and therefore can make compost to fertilize their land. They interplant sugarcane with peanuts, soybeans, sweet potatoes, and cotton during the early stages of production and thereby produce more crops per hectare than the corporation farms. TSC maintains its own farms largely because they provide a stable supply of sugarcane. Family farms have shifted from sugarcane to other crops as the other crops have become more profitable.

TSC has conducted research and field demonstrations on improved methods of growing sugarcane and has supplied farmers with fertilizer and pesticides. Thus, it has contributed greatly to the successful growing of sugarcane on family farms.

The Taiwan Pineapple Corporation and the Taiwan Tea Corporation also operate large farms much like those of TSC.

Cooperative Farms

The Chinese Government took over public lands from Japan after World War II, and under regulations issued in 1947 rented plots that were larger than 20 hectares to groups of farmers who operated them as cooperative farms. Farm members of cooperatives elected boards of directors and farm managers. At the end of 1947, there were 176 cooperative farms operating 18,900 hectares with 23,541 members, each representing one household. Sizes of these farms varied from 20 hectares with 11 members to 1,000 hectares with 1,400 members. Profits of the farms were divided among members according to the number of workdays they contributed to the farm.

These farms were not successful. As farm production belonged to farmers as a group, there was little incentive for individuals to work hard or carefully. It was difficult to measure fairly the work contributed by young and old, or by men and women. Moreover, members were reluctant to make capital investments. Consequently, production decreased.

As a result of this unsatisfactory experience, cooperatives decided to rent land to individual members for use as family farms. Cooperative marketing and purchasing facilities, however, were maintained. Beginning in 1950, individual farmers could purchase the land they had

been renting. Production on these farms has gradually increased like that on other family farms.

Taiwan also has had experience with cooperative farms on newly developed or reclaimed land settled by retired military servicemen who participated in the reclamation. The retired servicemen could decide whether to operate the land cooperatively or individually. Many cooperative farms were started in 1953. However, because of marriages and difficulties in effecting a fair distribution of work, some cooperatives were dissolved and became individual or family farms after 1958. Although some of these cooperative farms still exist, it is expected that they gradually will be converted to family farms.

Commercial Nature of Farming

Although farms in Taiwan are small, they are commercial enterprises. In the case of 600 farms for which detailed records were kept in 1965, nearly 60 percent of the farm production was sold for cash and another 5 percent was used to pay for seed, rent, and taxes and fees in kind (9). Altogether about two-thirds of all production moved off farms.

Farm expenses for fertilizer, feed, seed, pesticides, equipment and tools, irrigation, interest, and other items amounted to 40 percent of total farm receipts in 1965 (table 15). Net farm income was 60 percent of farm receipts. The net farm income of nearly NT\$35,000 per farm family is the return to management, unpaid family labor, and investment in land, buildings, and capital items.

These 600 farms averaged about 25 percent larger than all farms in Taiwan. However, data presented earlier (table 13) show that small farms also are highly market oriented. In the case of farms under 0.5 hectare in size, farm expenses account for about 40 percent of total farm receipts. Of course, small farms sell a smaller share of their total production. For example, in 1965 half of the farm receipts on farms under 0.5 hectare were in cash and half were in kind. Farm families with small farms perform more nonfarm work and have larger non-farm receipts than the families with large farms.

Because of the commercial nature of farming in Taiwan, farmers are very responsive to changes in prices of farm products and prices of farm inputs. For example, many have shifted land from sugarcane to rice, vegetables, and fruits in recent years, because of declines in prices of sugar relative to those for other crops.

Land Tenure Conditions

Taiwan has had many small farms since early settlement. However, a large share have been tenant operated. Moreover, large privately owned and Government-owned plantation-type farms also were important during the Japanese occupation, especially for sugar production.

TABLE 15.—Average data for 600 farm families, Taiwan, 1965

Farm receipts, expenses and income		Nonfarm income and related data	
Farm receipts:	NT\$	Nonfarm receipts:	NT\$
Crop and crop products	46, 335	Nonfarm expenses	8, 839
Livestock & livestock products	11, 790	Nonfarm income	461
Processed farm products	373	Farm family earnings	8, 378
Forestry	288	Farm household expenses	43, 114
Fishery	8	Net surplus	33, 089
Others	1, 140	Household expenses:	10, 025
Total	59, 934	Food	17, 066
Farm expenses:		Clothing	1, 612
Seed and seedlings	1, 184	Furniture	986
Fertilizer	6, 115	Education	1, 398
Human labor	2, 904	Social activity	1, 707
Animal labor	241	Medical	1, 300
Livestock and poultry	1, 857	Marriage and funeral	2, 305
Feed	6, 404	Others	6, 715
Farm equipment	1, 010	Total	33, 089
Insect, pest, and disease control	854	Persons in household:	No.
Irrigation charges	937	Adult	3. 96
Interest expenses	388	Old	. 47
Farm taxes and fees	1, 520	Infant	3. 80
Farm tools	318	Total	8. 23
Depreciation and repairs	182		
Land and other rent	1, 017		
Miscellaneous	267		
Total	25, 198		
Net farm income	34, 736		

Source: Compiled from (9). Farms were distributed through the country. They averaged 25 percent larger than all farms in Taiwan.

Landlords generally lived in larger towns and cities. Many subtenants lived in villages and acted as agents for landlords.

Grajdanec (11) reports that a large share of Taiwan's farmers were tenants and that fertile paddy land was concentrated in the hands of large landowners in the 1930's. About two-thirds of all farm families were tenants or part owners and only one-third were owners in 1932 and 1938 (table 16). The percentage distribution of owned and rented land was as follows in 1932:

Type of land	Owned	Rented	Total
	Percent		
Dry land	60	40	100
Paddy land	33	67	100
All cultivated land	46	54	100

It is especially important to note that two-thirds of the paddy land was rented. Paddy land is irrigated and has much higher yields than dry land. Moreover, paddy land produces two crops of rice each year and sometimes other crops in addition. Thus, agricultural production was concentrated on rented land.

TABLE 16.—*Number and percentage distribution of owners, part owners, and tenants, Taiwan, 1932 and 1938*

Item	Number of farmers		Percentage distribution	
	1932	1938	1932	1938
	<i>Thousands</i>	<i>Thousands</i>	<i>Percent</i>	<i>Percent</i>
Owners.....	132	130	33	31
Part owners.....	119	136	29	32
Tenants.....	153	159	38	37
Total.....	404	425	100	100

Reproduced from Andrew J. Grajdanev, (11, p. 76).

Ownership of land in Taiwan was unequally divided. In 1930, for example, landowners who owned less than 1 chia (2,397 acres) accounted for 64 percent of all holdings but for only 14 percent of all cultivated land (table 17). On the other hand, landowners who had 5 or more chia accounted for only 6 percent of all owners but for 50 percent of all land. Landowners with less than 0.5 chia, over 40 percent of the total, did not have enough land to provide a minimum living standard and depended upon rental of additional farmland or income from labor off their farms.

Grajdanev (11) reports that tenure conditions were unfavorable for tenants and favorable for landlords. The numerous tenants competed among each other for rental of land. Tenancy contracts were short, usually for only 1 year. They were oral contracts, and in case of conflict, the landlords were more successful than tenants in securing their interpretation of contracts. The landlord usually received security from the tenant in money or in kind, amounting to 40 to 60 percent of the rent deposited with the owner at the time the contract was made. No interest was paid on this amount. But tenants usually had to borrow at high interest rates to make these payments. Rental rates were high. Tenants paid 50 percent or more of their main crops to landlords for use of land.

The Japanese took steps to improve tenure conditions for tenants in the late 1930's. Government policy required that terms of tenancy be

TABLE 17.—*Distribution of landowners by size of holding, 1930*

Size of holding	Number of holdings	Land area	Percentage distribution		Average area per holding
			Holdings	Land area	
<i>Chia</i>	<i>Thousands</i>	<i>Thousand chia</i>	<i>Percent</i>	<i>Percent</i>	<i>Chia</i>
0-0.49.....	173	41	43	6	0. 24
0.50-0.99.....	87	62	21	8	. 72
1.0-4.99.....	122	259	30	36	2. 10
5.0 and over.....	23	359	6	50	15. 50
Total.....	405	721	100	100	1. 78

Reproduced from Andrew J. Grajdanev (11, p. 78).

extended to 5 or 6 years or more, that contracts be automatically renewed unless canceled by landlord or tenant 6 months before expiry, that rent be reduced by mutual consent in the case of crop failure, and that no contract be declared void before expiry without sufficient reason. Arbitration committees were set up to adjudicate disputes among landlords and tenants but they were dominated by the landlords' interests. The lot of the tenant did not improve significantly.

Tang and Hsieh (34) describe tenure conditions immediately before land reform in 1949-52 as highly unsatisfactory for tenants. They report that rental rates varied from 50 to 70 percent of the main crop and in addition tenants often had to pay "key money" to obtain use of land.

It is significant that tenure conditions apparently did not limit expansion in total agricultural production. As has been pointed out, agricultural output per hectare and per worker increased at relatively high rates during the 1920's and 1930's. This fact has relevance with regard to the role of economic incentives in securing increased agricultural productivity. Tenant farmers applied improved technology and used fertilizer and other inputs to increase crop yields. Their net incomes would have been lower if they had not done these things.

Land Reform

The Chinese Government recognized the need for land reform soon after Taiwan was ceded to China in 1945 (6). Land reform was carried out in three stages: (1) Rent reduction and other improvements for tenants beginning in 1949; (2) the sale of public land to tenants, initiated on a large scale in 1952; and (3) the land-to-the-tiller program (described below) beginning in 1953.

Under the rent reduction program, share rental rates that ranged from 50 to 70 percent of the main crops were reduced to 37.5 percent. Approximately 200,000 hectares of tenanted land (about 20 percent of the total cultivated area) were affected and about 300,000 tenants were benefited. All cultivated fields were surveyed and grouped in 26 grades according to productivity ratings for use in deciding rental. New 6-year lease contracts were written covering all rented land, and tenants had preferred rights to renew them. Advance payment of rent was abolished and no extra payments were permitted. Government inspectors were employed to see that the rent reduction program was carried out. Local farm tenancy committees with representation of tenants, landlords, and Government officials were appointed to adjudicate disputes and also assure that the rent reduction program was carried out according to law.

Sale of public land began in 1948 but then was discontinued for a few years and began again in 1952. By 1961 about 96,000 hectares of public land had been sold to about 200,000 tenant families. Land prices declined after the rent reduction program. Tenants who purchased

Government land paid the equivalent of 2.5 times the value of the annual crop yield. Payments for land were made over a period of 10 years.

Under the land-to-the-tiller program that was begun in 1953, 140,000 hectares or about 60 percent of the privately owned tenanted land was purchased by the Government and resold to tenants. The Government purchased all private tenanted holdings in excess of 3 hectares for paddy land and 6 hectares for dry land and resold it to tenants. The terms of sale were similar to those for public land: The purchase and resale price of land was fixed at 2.5 times the annual crop yield, and tenant purchasers paid the Government in 20 semiannual installments over a period of 10 years. The Government compensated landlords by paying them 70 percent of the purchase price with land bonds redeemable in kind (rice) and 30 percent in stock shares in four Government corporations. In this way landlords were assured that the value of land bonds would not depreciate and they became investors in industrial enterprises.

The land-to-the-tiller program did not involve the splitting up of large estates. Tenants who became owners were operating farmers and were accustomed to making managerial decisions. The payments they made for purchase of land usually were not larger than the rent they had been paying.

More farmers own the land they operate as the result of land reform programs. The percentage distribution of owners, tenants, and part owners has changed as follows:

Tenure status of farmers	Percent before land reform, 1949	Percent after land reform, 1957
Owners-----	36	60
Tenants-----	39	17
Part owners-----	25	23
Total-----	100	100

Small farm units which are family owned and operated have increased in importance. In 1953, owner-cultivated land accounted for 85 percent of all privately owned farmland and tenant-operated land for only 15 percent. Only 23 percent of all farmland was in holdings of 3 hectares or more in 1955, as compared with 42 percent in 1952.

Land reform benefited the economic and social welfare of farm-people and also provided increased incentives to intensify land use and increase agricultural production. Tang and Hsieh (34) show that the following changes took place from 1950 to 1955: (1) Wages or incomes farm families received for their labor increased as rental payments decreased, (2) outflow of net farm income to other sectors decreased, (3) consumption expenditures of farmpeople increased, (4)

farm investment increased absolutely but decreased relative to total net farm income, and (5) total agricultural output increased 22 percent, a relatively high rate of about 4 percent a year.

Koo, who has analyzed the effects of land reform in Taiwan in great detail (21), says that "the impetus to agricultural development was provided by land reform after the end of the second world war." He points out that there has been no tendency for tenants to utilize wind-fall gains in income resulting from reduction in rental payments to reduce their labor inputs and enjoy more leisure. Capital inputs went up greatly in the 1950's, as observed earlier. Moreover, the more equitable distribution of land among farmers tended to reduce disguised unemployment. Farm families apparently have utilized a part of their larger incomes to increase education. The percentage of primary-school-age children in school increased from 71 percent in 1940 to 96 percent in 1960. Mobility of farm people, including migration to nonfarm employment, is associated with more education according to Koo.

Land reform undoubtedly has had favorable effects on agricultural development. Tenants who became owners took an active part in local government and group organizations such as farmers' associations, irrigation associations, and cooperatives. In fact, leadership of rural organizations shifted to farmers who tilled the land. Land reform had a stabilizing influence on rural society as grievances between tenants and landlords were removed. While land reform could not solve the problem of increasing population pressure upon limited land resources, it enabled farmers to exercise increased control over their economic and social welfare.

CHAPTER VII.—LAND AND WATER DEVELOPMENT

The extreme scarcity of land resources in Taiwan has made it necessary to utilize arable land to grow crops the year around wherever possible. Fortunately, Taiwan as a whole has abundant rainfall. But it is unevenly distributed throughout the year and also throughout the island. For example, some agricultural areas in the northeast and in the mountains receive over 150 inches a year fairly well distributed throughout the year, but the southwest coast receives less than 40 inches, mainly during April through September. Heavy rainfall in hilly and mountainous areas provides potentials for irrigation of the lower level areas, and rapid runoff from torrential rains require flood control measures.

Irrigation Development

Irrigation in Taiwan can be traced back to the 14th century when the first emigrants came from mainland China and began farming. By 1895, over 200,000 hectares had been developed for growing rice,

over half of which was irrigated by ponds and canals. Almost all irrigation canal systems were built by private individuals without Government aid.

The irrigated area increased rapidly during the Japanese occupation, and by 1945, had increased to 547,000 hectares. Of this total, 462,000 hectares were irrigated by irrigation associations and 85,000 by individuals. Construction of irrigation projects was planned and carried out by the Government. Farmers paid a part of the costs through membership in irrigation associations.

During World War II, the irrigated area decreased by about 260,000 hectares, due to destruction of irrigation facilities and lack of maintenance. One of the first tasks after restoration of Taiwan to the Republic of China was rehabilitation of irrigation systems from damages caused by floods as well as by wartime destruction. This was completed about 1955. Since then, many irrigation projects have been constructed to make more adequate use of available water supplies and to provide flood control protection. In addition, some large-scale multiple-purpose projects, like the Shihmen project, which provide electric power, flood control, and irrigation water have been completed.

In some areas where water supplies are limited, rotational irrigation systems have been put into operation to use limited water supplies more effectively and to increase crop yields. Also, irrigation from deep wells is practiced in coastal areas where established irrigation systems do not supply enough water.

Intensive Land Use

The total planted area of crops has increased steadily since the early 1900's, largely due to the increase in irrigation (table 18). Most of

TABLE 18.—*Agricultural land use and irrigation in Taiwan*

Year	Cultivated land				Total planned area ¹	Multiple- cropping ratio	
	Total	Irrigated paddy field					Dry land
		Subtotal	Double- crop paddy	Single- crop paddy			
		Thousand hectares			Percent		
1910-----	675	332	-----		343	827	123
1915-----	700	343	-----		357	921	132
1920-----	749	367	246	121	382	955	127
1925-----	775	373	266	107	402	1, 105	142
1930-----	808	396	292	104	412	1, 194	148
1935-----	831	479	313	166	352	1, 343	162
1940-----	860	529	324	205	331	1, 366	159
1945-----	816	505	298	207	311	1, 067	131
1950-----	871	530	320	210	341	1, 682	193
1955-----	873	533	333	200	340	1, 641	188
1960-----	869	526	329	197	343	1, 718	198
1965-----	890	537	337	200	353	1, 766	198

¹ Includes green manure crops.

Source: Rural Economics Division, JCRR.

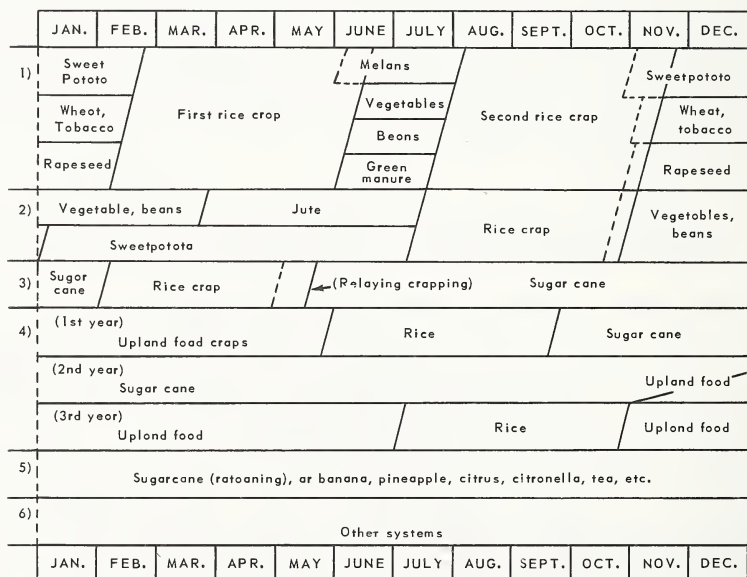
the land suitable for arable use was brought under cultivation by 1940. In recent years growth of urban areas has occupied some farm land in lowland areas, but this has been offset by bringing additional land under irrigation and by increased use of dry land for crops in sloping land areas.

The growth in total planted acreage had been made possible by increased multiple cropping. In areas where water is plentiful, farmers often grow four crops a year (fig. 9). Farmers have increased acreages of vegetables to better use available land and water. Other crops are often interplanted in ricefields before the rice harvest.

Irrigation Investments

Irrigation development requires that labor and capital be invested in facilities that will expand crop production over many years in the future. In addition, annual expenditures must be made for main-

MULTIPLE CROPPING SYSTEMS IN TAIWAN



- 1) Three or four-crop-a-year system in double-cropping paddy land.
- 2) Two or three-crop-a-year system in single-cropping paddy land.
- 3) The sugarcane-rice relay cropping system.
- 4) The sugarcane/rice/upland-food-crop rotational system.
- 5) The year-round-growing system of long-term crops.
- 6) Besides the above, there are still several other systems such as the six to seven-crop-a-year vegetable farm, and a newly developed 80-20% device for land use of rice-pasture farm -- 2 rice crops and pasture the rest of the year.

tenance and operation. Often there are related benefits such as flood control. These conditions complicate the measuring of economic costs and returns from irrigation projects.

Irrigation investment was viewed by the Government as an infrastructure investment necessary for agricultural development, similar to investments in education, research, police protection, transportation, and communications. As irrigation investments provide economic returns over a long term in the future, the use of current high interest rates to determine the present value of irrigation investments would indicate that the present value of returns from these investments would be very low and the investments uneconomic. The important economic question was not whether or not to make investments for irrigation but where scarce capital for irrigation development would yield the highest economic returns. It also was recognized that irrigation development required group action by landowners or by Government organizations working with them.

Rada and Lee (28) present data on investment and operational outlays for irrigation by the Government and irrigation associations for 1901-60 in their study of irrigation investment in Taiwan (table 19). As pointed out by the authors, these data have limitations for

TABLE 19.—*Investment and operational outlays for irrigation by government and irrigation associations, 1935-37 prices, 1901-60*

Years	Investments for irrigation			Operational outlays	Total paddy field	Operational costs per hectare
	Total	Government	Irrigation associations			
	<i>Thousand 1935-37 Taiwan dollars</i>				<i>Thousand hectares</i>	<i>1935-37 Taiwan dollars</i>
1901-10	6, 230	5, 731	499	9, 417	2, 949	3. 19
1911-20	9, 457	8, 606	851	19, 049	3, 413	5. 58
1921-30	81, 765	28, 618	53, 147	131, 438	3, 788	34. 70
1931-40	24, 710	7, 660	17, 050	93, 569	4, 822	19. 40
1941-45	15, 864	11, 105	4, 759	31, 687	2, 579	12. 29
1946-50	3, 997	-----	-----	18, 404	2, 609	7. 05
1951-60	21, 168	9, 526	11, 642	47, 902	4, 792	10. 00

Source: Rada and Lee (28, pp. 134-136).

several reasons: (1) Collective expenditures in the form of free labor service spent on irrigation facilities and land donated for joint irrigation enterprises are not accounted for; (2) it is difficult to separate new investment from funds used to replace depreciated, destroyed, or obsolete facilities; and (3) changing prices, especially during World War II and immediately after, affect comparability of time series data even after adjusting for price level changes. Nevertheless, it is evident that very large investments were made for irrigation in the 1920's and 1930's. Until 1920, Government accounted for about 90 percent of total investments, but during the 1920's and 1930's irri-

gation associations accounted for about 60 percent of total investment. Operational outlays also were very large in those decades.

Although investments and expenditures for irrigation were very large, they were small compared with the total value of additional agricultural production. For example, annual operational costs for irrigation were equivalent to less than 2 percent of the annual value of agricultural production during 1911–20. The comparable figure was less than 4 percent in the 1930's and 1940's. Investment for irrigation was less than operational costs in each year. Thus, expenditures for irrigation, including investment, did not exceed 8 percent of the total value of agricultural products in any one year.

Operational costs for irrigation on a per hectare basis are relatively low. For example, in 1951–60, they averaged about NT\$280 or about \$7 per acre of irrigated land.

Irrigation Associations

Members of irrigation associations organized during the Japanese occupation were mainly landowners. As indicated earlier, a large part of the investment costs of irrigation development carried out by these associations was borne by the Government. Members were required to pay membership dues, and fees in proportion to the number of hectares they had under irrigation. Fees paid per hectare for water varied widely from one association to another. These associations were supervised closely by Government officials.

After the war irrigation associations came under the direction of the Provincial Water Conservancy Bureau. The number of irrigation associations was reduced to 26 and they were reorganized to bring them under control of farmer members. Members elect representatives who meet twice a year to elect a chairman. He is authorized to appoint a general manager to help carry out policies and programs agreed upon by the representatives. Annual revenues come from membership fees and dues. The annual budget is drawn up to meet the expenses of administration, maintenance, and damage repairs. The Government has set as a maximum fee the value of 300 kg. of paddy rice and a minimum of 20 kg. per hectare per year, but representatives fix the rates within these limits. Special assessments may be made for new capital and interest costs.

The Government will subsidize 50 percent of the total cost of new irrigation projects, and will provide loans at interest rates of 8 to 10 percent per year for the remaining 50 percent. Thus, the policy of supporting irrigation as a type of infrastructure investment has been continued. However, questions sometimes are raised concerning the economy of making investments for irrigation to achieve a larger agricultural production, compared with making investments for industrial development.

Land Consolidation and Improvement

A land consolidation and improvement program was initiated in Taiwan in 1961 to consolidate the many small plots operated by each farmer and to improve irrigation, drainage, and roads. Approximately 110,000 hectares have been consolidated and improved thus far. It is expected that 300,000 hectares will be improved by 1971 and 700,000 hectares by 1980.

The procedure is first to designate regions of about 100 hectares in size, set up administrative arrangements for carrying out land consolidation and improvements, conduct land surveys, prepare lists of areas and quality of land, and prepare proposals for field layouts, irrigation ditches, roads, and so forth. At least 50 percent of the land-owners in an area must approve the proposal before it can be initiated. Construction work and laying out of new fields is usually done in about 3 months during the fallow period between harvesting of the second rice crop and planting of the first. Program costs are of two types: Operational expenses averaging about NT\$400 or US\$10 per hectare, and engineering expenses averaging about NT\$4,000 or US\$100 per hectare. Operational expenses are borne by Government agencies. Before 1963, Government agencies paid half of the engineering costs and farmers paid the other half. But beginning in 1963, farmers have paid all engineering costs. Loans at relatively low interest rates, 6 percent a year, are available to farmers to pay these costs.

Land consolidation and improvement have benefited farmers in several ways. They increase crop production about 30 percent, result in savings of irrigation water up to 20 percent, improve opportunities to use mechanization, increase effectiveness of pest control measures, reduce the area used for roads and paths to fields, and make fields more readily accessible. The program uses trained personnel to plan and supervise the projects, much labor which usually is supplied by farm people in the community, and some materials and equipment. Land consolidation and improvement plans are coordinated with other activities (building reservoirs, tapping ground water to supplement irrigation water, and lining irrigation canals to conserve water).

Farmers became receptive to land consolidation and improvement programs once their benefits were demonstrated. Only the resources available for these programs limit the rates at which they are carried out.

CHAPTER VIII.—CAPITAL AND CREDIT

Agricultural development in Taiwan has required large amounts of capital for use in farm production and in farm marketing and supply industries. Total working capital inputs used in farming, including fertilizer, pesticides, feed, tools and equipment, and other materials, averaged 6 times larger in 1961-65 than in 1911-15 (table

20). Similarly, fixed capital inputs for buildings, draft animals, live-stock, poultry, and farm machinery averaged nearly 5 times larger. As expenditures and investments by farmers for capital items went up, farmers have required more credit to finance their farming operations.

Capital Inputs on Farms

Capital inputs accounted for 32 percent of all inputs used annually in farm production in 1961-65 compared with only 11 percent in 1911-15 (table 3). Not only have the amounts of capital used increased, but farm production has become increasingly dependent upon purchased capital inputs. Capital inputs purchased by farmers from non-farm sources accounted for 67 percent of all capital inputs in 1961-65, compared with only 37 percent in 1911-15 (table 20). However, farm production was highly dependent upon purchased capital inputs as early as 1936-40.

Expansion of working capital inputs from nonfarm sources is due mainly to large increases in purchases of fertilizer, pesticides, and imported feeds. The rapid growth in pesticide use is especially noteworthy. However, pesticides still accounted for only 6 percent of all capital inputs in 1961-65, while fertilizer accounted for 35 percent.

Fixed capital inputs from nonfarm sources have increased, mainly as the result of greater use of farm machinery and equipment. It is significant that fixed capital inputs from farm sources show an abso-

TABLE 20.—*Changes in capital inputs by categories, Taiwan, selected periods*

Items	Percentage distribution			Percentage changes		
	1911-15	1936-40	1961-65	1911-15	1936-40	1961-65
Working capital:						
Farm source.....	51	23	31	100	145	352
Nonfarm source.....	29	58	53	100	644	1, 088
Fertilizer.....	14	40	35	100	951	1, 509
Pesticides.....	1	1	6	100	248	3, 084
Other ¹	14	17	12	100	382	530
Subtotal.....	80	81	84	100	325	617
Fixed capital:						
Farm source.....	12	3	2	100	78	92
Nonfarm source.....	8	16	14	100	666	1, 036
Subtotal.....	20	19	16	100	310	465
Total, farm source.....	63	26	33	100	133	303
Total, nonfarm source.....	37	74	67	100	649	1, 077
Total, both sources.....	100	100	100	100	322	587

¹ Mainly imported feed.

Source: Rural Economics Division, JCRR.

lute as well as a relative decrease, reflecting a reduction in the number of draft animals.

Data referred to earlier showing farm expenses for 600 farm record-keeping households in 1965 also show the importance of capital inputs in agriculture (table 15). Some items like seed and seedlings and feed which are from farm sources also are purchased by farmers. In addition, farmers have expenses for hired labor, animal labor, interest, taxes, and rent which must be paid for in cash or in kind.

Financial Position of Farmers

Farmers in Taiwan have relatively large investments in land, buildings, orchards, trees, and farm machinery, even though their farms are small. In 1965, for example, total assets per farm averaged NT\$218,000 (about US\$5,450) for the 600 farm recordkeeping households (table 21).

TABLE 21.—*Balance sheet of 600 farm families, Taiwan, Dec. 31, 1965*¹

Items	Average per farm	Average per hectare	Percentage distribution
	NT\$	NT\$	Percent
Total assets.....	217, 908	171, 581	100
Liquid assets ¹	36, 450	28, 701	16. 7
Fixed assets.....	181, 458	142, 880	83. 3
Land.....	149, 040	117, 354	68. 4
Buildings.....	23, 463	18, 475	10. 8
Orchards and trees.....	4, 116	3, 241	1. 9
Farm machinery.....	4, 839	3, 810	2. 2
Total liabilities.....	11, 384	8, 964	5. 2
Current.....	11, 311	8, 907	5. 2
Fixed.....	73	57	(²)
Net worth.....	206, 524	162, 617	94. 8
Capital.....	196, 499	154, 723	90. 2
Surplus during the year.....	10, 225	7, 894	4. 6

¹ Includes cash, bank deposits and accounts receivable, farm products in storage, crops growing in fields, and livestock and poultry.

² Less than 0.1 percent.

Source: (9).

Values for land with irrigation facilities are very high—about NT\$117,000 (nearly US\$3,000) per hectare. In some areas, land values of NT\$300,000 (US\$7,500) per hectare have been reported. These high land values reflect the extreme scarcity of land. Economic returns to land and capital appear relatively low. The 600 farm recordkeeping households had net farm incomes averaging NT\$35,000 in 1965. If a charge is made for unpaid family and operator labor, the return to land and capital investment would be very low. The importance of land in total farm investment is indicated by the fact that it accounted for 68.4 percent of total assets of the recordkeeping farms (table 21).

Farmers do not have large debts. Liabilities of the farm record-keeping households averaged only about NT\$11,000, or less than a

third of liquid assets at the end of 1965. Current liabilities or short-term debts are much larger than long-term debts on fixed assets.

Capital Formation

Estimates of net capital formation or the total value of land and capital investments in agriculture are not available. However, estimates of gross capital formation in agriculture are available for years since 1953 (table 22). They show that capital formation in agriculture has increased at about the same rate as the total value of agricultural production. Gross capital formation has averaged around 6 percent of the total value of agricultural production since 1953. These data suggest that the capital output ratio in agriculture has not changed significantly.

Gross capital formation by agricultural agencies includes investments for flood control and irrigation, land reclamation and improvement, planting orchards, machinery, equipment, and farm construction, and other items financed by the Provincial Water Conservancy Bureau, Provincial Food Bureau, Taiwan Sugar Corporation, farmers' associations, the Joint Commission on Rural Reconstruction, and other agencies. Investments by individuals in farm improvements have increased more rapidly than capital investments by agricultural agencies.

Agricultural Credit

Agricultural credit programs in Taiwan have been described in detail by the agricultural credit division of JCRR (2). Before 1950, pri-

TABLE 22.—*Gross capital formation in agriculture and total value of agricultural production, Taiwan, 1953-65*

Year	Gross capital formation			Total value of agricultural production	Gross capital formation as a percentage of agricultural production
	Private farm improvements ¹	Agricultural agencies ²	Total		
			<i>Million NT\$</i>		<i>Percent</i>
1953-----	245	168	413	9,097	4.5
1954-----	265	199	464	7,896	5.9
1955-----	300	322	622	10,001	6.2
1956-----	402	331	733	11,158	6.6
1957-----	403	383	786	13,126	6.0
1958-----	424	493	917	14,525	6.3
1959-----	497	739	1,236	16,611	7.4
1960-----	484	794	1,278	21,856	5.8
1961-----	631	693	1,324	24,413	5.4
1962-----	253	811	1,064	24,807	4.3
1963-----	502	632	1,134	26,039	4.4
1964-----	598	908	1,506	31,263	4.8
1965-----	1,272	581	1,853	32,158	5.8

¹ Capital investment of individual farmers.

² Investments made for flood control and irrigation, orchard plantings, machinery and equipment, land improvements, and related items made by agricultural organizations.

Source: Rural Economics Division, JCRR.

vate moneylenders, particularly landlords, played a dominant role in agricultural financing. They supplied 82 percent of the credit used by farmers in 1949. However, land reform brought about drastic changes in the agricultural credit system. Economic and personal ties between landlords and tenants loosened, and former landlords became less interested in making agricultural loans. Fortunately, this gap was gradually filled by a continuous flow of credit from other sources. In 1960, private lenders supplied only 43 percent of the borrowings of farmers while credit institutions and Government agencies supplied 57 percent. In 1965, credit institutions and Government agencies supplied 65 percent of all agricultural loans.

Institutional credit for agricultural activities is now made available through a number of agricultural credit institutions and Government agencies and enterprises (table 23). About one-fourth of the agricultural loans are made to farmer organizations such as irrigation associations, farmers' associations, marketing cooperatives, and fishermen's associations, and three-fourths are made to individual farmers. The Taiwan Sugar Corporation makes loans directly to individual farmers. Food Bureau loans are made through credit departments of farmers' associations. About half of JCRR loans are made to individual farmers through farmers' associations, and about half are made to irrigation

TABLE 23.—*Agricultural loans of agricultural credit and Government agencies, Taiwan, Dec. 31, 1965*

Lending agency	Long term (over 5 years)	Intermediate terms (1 to 5 years)	Short term (up to 1 year)	Total
<i>Million NT\$</i>				
Agricultural credit institutions:				
Land Bank of Taiwan.....	1, 202	1, 024	378	2, 604
The Cooperative Bank of Taiwan.....	76	11	1, 332	1, 419
Farm Credit Department, farmers' associations.....		732	2, 453	3, 185
Subtotal.....	1, 278	1, 767	4, 163	7, 208
Government enterprises:				
Taiwan Food Bureau.....	2	75	232	309
Taiwan Sugar Corporation.....		475		475
Subtotal.....	2	550	232	784
JCRR.....	852	23		875
Total.....	2, 132	2, 340	4, 395	8, 867
Duplications ¹	487	306	631	1, 424
Net ¹	1, 645	2, 034	3, 764	7, 443

¹ Duplications are loans by one agency to another such as loans by JCRR to farmers' associations which in turn make loans to individual farmers. The net data exclude duplications.

Source: Agricultural Credit Division, JCRR.

associations and other organizations for improving their facilities. About two-thirds of the agricultural loans of the Land Bank of Taiwan and the Cooperative Bank of Taiwan are to individual farmers. The remaining third are to agricultural organizations.

Institutional lending agencies may be described briefly as follows:

1. THE PROVINCIAL FOOD BUREAU makes loans to farmers through township farmers' associations for producing rice, other food crops, and hogs, and also for purchasing farm implements. As the Bureau is concerned with the production, collection, distribution, and export of rice, most of its loans must be repaid in kind (rice).

2. THE TAIWAN SUGAR CORPORATION makes loans to farmers who contract to grow sugarcane. Loans are made in cash and in kind, mainly fertilizer, through local sugar mills and must be repaid in kind with sugar. No interest as such is charged. The quantity of sugar required for payment of loans depends upon an official price for sugar set by the corporation. The corporation also makes loans to contract growers of pineapples and mushrooms. These loans are repaid with cash.

3. THE PROVINCIAL TOBACCO AND WINE MONOPOLY BUREAU used to extend loans through the Tobacco Growers' Association to tobacco growers both in cash and in kind for fertilizer, pesticides, implements, and materials for production and curing of tobacco leaves. Loans in kind are still made by the Bureau while cash loans now are made by the Land Bank of Taiwan and the Cooperative Bank of Taiwan. Both types of loans are repaid in cash from proceeds from sale of tobacco leaves. No interest is charged on loans in kind.

4. THE PROVINCIAL SUPPLY BUREAU makes loans to farmers through farmers' associations for producing jute. Loans are repaid from sale proceeds of jute fiber which is collected by farmers' associations for the Bureau. Three-fourths of the loans are interest free.

5. THE JOINT COMMISSION ON RURAL RECONSTRUCTION provides agricultural institutions and farmers' organizations with financial assistance in the form of grants and loans. It carries out a farm credit program designed to make more credit available to farmers for improving their farming operations and to increase the lending capital of farm credit institutions. Loans are made for irrigation; crop, animal, and fishery production; and rural electrification. Loans to farmers are made through farmers' associations and agricultural banks.

6. THE LAND BANK OF TAIWAN is a Government bank engaged in land and agricultural financing. It has 36 branches in principal cities and townships located over the island. It makes loans for farm production, agricultural marketing and processing activities of farmers' associations, irrigation, farm ownership, land improvement, fishery activities, and housing. Loans are made to individual farmers as well as to their organizations.

7. **THE COOPERATIVE BANK OF TAIWAN** provides financial assistance to both agricultural and nonagricultural cooperative associations including farmers' associations, irrigation associations, marketing cooperatives, warehousing cooperatives, and cooperative farms. Almost four-fifths of its loans are for agricultural and fishery purposes. It has 35 branches, 49 agents, and 231 remittance correspondents distributed over the island. Loans to individual farmers usually are made through their organizations.

8. **TOWNSHIP FARMERS' ASSOCIATIONS** have credit sections which make loans to members for farming and nonfarming uses. The credit sections receive deposits, make loans, handle remittances, and keep accounts for the associations. Borrowings from the Land Bank and Cooperative Bank and in addition to deposits of members provide funds for loans. The credit section also finances marketing, supply, processing, and warehousing businesses of associations. Most loans to farmers are made without collateral but are guaranteed by two or more people.

Agricultural loans made by Government enterprises and credit institutions have increased greatly since 1953 (table 24). Outstanding loans by these organizations amounted to 24 percent of the total value of agricultural production in 1965, compared with only 7 percent in 1953.

TABLE 24.—*Agricultural loans made by Government enterprises and credit institutions outstanding at end of year, Taiwan, 1953-65*

Year	Loans outstanding at end of year				Gross value of agricultural production	Loan-to-value ratio
	Government enterprises ¹	JCRR	Credit institutions ²	Total		
	<i>Million NT\$</i>					<i>Percent</i>
1953.....	464	31	224	719	10,390	6.9
1954.....	601	50	281	932	9,429	9.9
1955.....	413	44	371	828	11,662	7.1
1956.....	418	84	567	1,069	13,017	8.2
1957.....	372	107	667	1,146	15,423	7.4
1958.....	489	128	1,112	1,729	17,314	10.0
1959.....	568	195	1,548	2,311	20,137	11.5
1960.....	777	311	1,573	2,661	25,743	10.3
1961.....	654	396	2,686	3,736	28,368	13.2
1962.....	872	537	4,460	5,919	28,475	20.8
1963.....	778	708	4,305	5,791	30,048	19.3
1964.....	931	815	5,807	7,553	35,945	21.0
1965.....	784	875	7,208	8,867	37,475	23.7

¹ Includes Provincial Food Bureau, Taiwan Sugar Corporation, Provincial Supply Bureau, and Provincial Tobacco and Wine Monopoly Bureau.

² Includes Land Bank of Taiwan, Cooperative Bank of Taiwan, and Township Farmers' Associations.

Source: Compiled by Agricultural Credit Division, JCRR.

Institutional loans outstanding on December 31, 1966, classified by categories were as follows :

	<i>Million NT\$</i>
Crops -----	6,208
Forestry -----	110
Fisheries -----	888
Livestock -----	407
Processing and marketing -----	1,578
Purchase of farmland -----	600
<hr/>	
Total -----	9,791

Agricultural loans are used mainly to finance crop production, marketing, and processing. Loans for purchase of farmland account for a small part of the total.

Unified Agricultural Credit Program

The agricultural credit system in Taiwan has been improved in recent years through the Unified Agricultural Credit Program. (1).

The credit sections of farmers' associations play a dominant role in rendering credit services to farmers. However, in the past they have had little opportunity for accumulating capital and have had little capital of their own. Assets and liabilities of the credit programs were intermingled with those of other programs and any profit from credit activities was used mainly to finance extension work. Consequently, credit sections had to rely upon member deposits and bank loans for relending purposes. Member deposits vary widely and do not provide a basis for long-term loans. Also, reliance of economic sections of farmers' associations on credit sections tended to reduce funds available for loan to farmers.

Lending procedures of credit sections also needed improvement. In screening loan applications, attention was given mainly to adequate security and only limited attention to purposes of the loans and how they would increase farm production and incomes of farmers. Little technical assistance was given to farmers in connection with loans. Terms of loans usually were too short to meet actual requirements and loans usually had to be renewed and extended. Collection of interest each month added to the workload of credit sections.

During 1955-60, JCRR carried out six agricultural credit projects under which loans were made to township farmers' associations, the Cooperative Bank, and the Land Bank. Over half of the township farmers' associations participated in these projects. The projects were tests and demonstrations of how funds could be made available to provide dependable loan funds for credit sections, how lending practices could be improved, and how loan funds could be made available to farmers who had not used institutional credit.

Based on experience gained from these tests and demonstrations, JCRR initiated the Unified Agricultural Credit Program in 1961 to

provide a permanent and dependable source of lending funds to finance farm production and to improve financial resources and services of agricultural credit institutions. An agricultural credit fund of NT\$300 million from counterpart funds was established. Two-thirds was for loans directly to farmers' associations and one-third indirectly through the Land Bank and the Cooperative Bank. Farmers' associations use these loans to increase their funds for loans to farmers. An agricultural credit planning board, consisting of representatives from eight central and provincial agencies, was set up to make policy and administer the agricultural credit fund.

It was decided that the Land Bank would make loans for terms longer than 12 months and the Cooperative Bank for 12 months or less. The two banks agreed to add from their own funds not less than one-fifth of the amount of the loans made to farmers' associations. The interest rate from the agricultural credit fund to the two banks is 8.58 percent a year and that from the two banks to farmers' associations is 10.08 percent a year.

Credit sections of farmers' associations have been strengthened by the NT\$200 million made available to them in 1961 as loans at no interest. These loans are to be repaid in five annual installments beginning at the end of the fourth year after the date of the loan. Farmers' associations participating in the Unified Agricultural Credit Program agree to follow improved loan practices. Funds and accounts of the credit sections are segregated from those of other sections. Credit sections are permitted to accumulate earnings. Farmers who borrow from the credit section must invest in it an amount equal to at least 5 percent of their outstanding loans. A credit advisory committee is set up to advise the farmers' association on credit needs for farmers and help explain the program to them. A farmer's association is required to utilize at least 70 percent of the deposits from its farmer members before it makes Unified Agricultural Credit loans. In addition, farmers' associations that participate agree to use approved lending practices.

Loan applications can be made by any member of a farmers' association. A credit officer visits the farmer to obtain detailed data about his financial condition and farming plan and makes recommendations concerning the loan. This loan application report is reviewed by the chief of the credit section and then submitted to the general manager of the farmers' association for final approval. Maximum term of loans is 5 years. Loans are mainly to finance production of crops and livestock and purchases of equipment and machinery. Interest rates are 1.25 percent per month for unsecured loans and 1.11 percent for secured loans. Payment of interest is made each 6 months. To help borrowers get maximum benefit from a loan, and to insure the collection of loans on time, credit and extension specialists of farmers' associations guide and supervise the use of loans.

Of the 295 township farmers' associations that have credit sections, 249 were participating in the Unified Agricultural Credit Program in 1967. Farm loans are increasing and credit sections of farmers' associations are accumulating earnings. To help associations accumulate capital the Provincial Government is providing them with funds for extension work to substitute for funds formerly supplied by the credit sections.

Financing Fertilizer Use

Fertilizer distribution in Taiwan is controlled chiefly by the Provincial Food Bureau. It distributes fertilizer through farmers' associations to individual farmers under a barter system whereby fertilizer is exchanged for rice at specified ratios. Farmers must pay 40 percent of the rice at the time they receive the fertilizer, and they repay the other 60 percent after the rice is harvested. In effect, the fertilizer barter program helps finance farm production. In 1965, the total value of rice delivered to the Provincial Food Bureau was NT\$1,605 million. If we count only 60 percent of this, the total value of these fertilizer loans was NT\$963 million, an amount equal to more than 10 percent of all agricultural loans at the end of 1965.

As pointed out earlier, TSC, TWMB, and other organizations also make fertilizer loans to farmers for sugarcane and tobacco. Farmers' associations also sell fertilizer to farmers for use on other crops. However, the Provincial Food Bureau coordinates and controls the use and distribution of fertilizer.

Some Conclusions

It is significant that use of capital inputs increased rapidly during 1910-40 when there was no well-developed institutional credit system. Individual moneylenders apparently were the chief sources of farm credit in this period. Little information is available concerning interest rates but they undoubtedly were high. Moneylenders also carried out marketing functions for farmers.

Interest rates on loans to farmers of 1.05 to 1.11 percent per month or 12.6 to 13.3 percent a year for unsecured loans under the Unified Credit Program may appear high. But it must be remembered that loan amounts are small and often extend for only a few months. Administrative costs absorb a large part of the total interest charge. Moreover, high interest rates reflect the fact that capital inputs are relatively scarce and yield relatively high economic returns.

Land values are so high that few farmers purchase land and pay for it out of land earnings. Most farmers have received their land by inheritance or have purchased it under land reform programs.

CHAPTER IX.—FARM PRICES AND MARKETS

Prices and markets for farm products, production inputs, and consumption goods influence economic incentives to apply improved technology and increase agricultural productivity (31). However, Taiwan's experience indicates that assured market outlets for farm products and readily available supplies of production inputs which reduced price uncertainty and risk were fully as important as favorable input-product price ratios in providing economic incentives to expand farm production. Moreover, it indicates that a continuing flow of new technology is essential for sustained expansion in agricultural output. Profits from the use of capital inputs depend as much upon the increases in production resulting from the use of these inputs as they do upon prices of products and inputs. Although a rise in prices of farm products relative to prices of inputs may lead to increased production, it is at best only a temporary source of additional output.

Marketing Facilities

Facilities for marketing most farm products and distributing farm production requisites are well developed in Taiwan. Good transportation facilities are supplied by railroads and highways. Farmers do not need to travel very far to reach local market centers. Township farmers' associations provide milling and storage facilities for rice and sell production requisites and consumption goods. They also market hogs, poultry, tobacco, peanuts, soybeans, and other crops. Fruit and vegetable marketing cooperatives provide transportation, processing, and selling services and also are directly engaged in exporting bananas, citrus fruit, canned fruit and vegetables, and other items. The Taiwan Sugar Corporation transports sugarcane from individual farms and processes it in several refineries that are distributed around the island. In addition, there are many private individuals and companies engaged in marketing activities.

The present marketing system has been built up over a long period. Some sugar refineries were established in Taiwan before Japanese occupation. Also, some railway lines had been constructed. But large investments were made for improving railway and highway transportation and farm marketing facilities under Japan; many local cooperative associations were established for marketing farm products and distributing farm supplies. However, marketing facilities have been improved greatly in the last 20 years.

Marketing efficiency for most farm products is relatively high. According to studies made during the late 1950's, the farmers' share of the retail price of the individual commodities was as follows: Rice, 68 percent; sweet potatoes, 45 percent; peanut oil, 84 percent; bananas, 37 percent; hogs, 65 percent; and poultry, 76 percent.

Marketing Arrangements

RICE.—The Provincial Food Bureau, operating through township farmers' associations, is engaged in collection and price stabilization activities for rice. Through the fertilizer-rice barter system, land tax collection in kind, compulsory purchase of rice from landowners, and repayment in kind of production loans made by the Bureau to farmers, the Provincial Food Bureau controls about 30 percent of the rice, or nearly 60 percent of that marketed by farmers (table 25). About 50 percent of this rice is disposed of as rations to armed forces and Government civil servants, including schoolteachers and their dependents; 20 percent is sold into free markets at retail and wholesale levels for price stabilization purposes; and the remaining 30 percent is exported.

TABLE 25.—*Rice collections by the Provincial Food Bureau, 1960 and 1965*¹

Items	1960	1965	Percentage of production	
			1960	1965
	<i>Thous. metric tons</i>	<i>Thous. metric tons</i>	<i>Percent</i>	<i>Percent</i>
Rural land tax in kind.....	75	97	3.9	4.1
Compulsory purchase.....	57	62	3.0	2.6
Rent from public land.....	2	38	.1	1.6
Payments in kind under the land-to-the-tiller program.....	17	10	.9	.4
Fertilizer barter.....	293	397	15.3	16.9
Repayment of production loans.....	9	8	.5	.3
Others.....	13	42	.7	1.8
Total collections.....	466	654	24.4	27.9
Year-end stocks.....	140	401	7.3	17.1
Total production.....	1,912	2,348	100	100

¹ Brown rice equivalent.

Source: Compiled by Rural Economics Division, JCRR, from financial operating statements of the Provincial Food Bureau.

The Provincial Food Bureau announces after harvest of each crop the official price for the rice it collects. These prices have averaged 20 to 30 percent below free-market prices in recent years. Township farmers' associations carry out the collection, milling, and storage of rice for the Bureau for specified fees. The Provincial Food Bureau maintains large stocks of rice to assure adequate supplies in case of crop failures, and engages in buying and selling to prevent violent fluctuations in rice prices. It handles all exports and imports of rice and also distributes some rice to needy families.

Farmers' associations market much of the free-market rice sold by farmers. This rice accounts for about 20 percent of the rice produced.

SUGARCANE.—The Taiwan Sugar Corporation, a Government enterprise, owns and operates all of the 25 sugar refineries in Taiwan. It

owns 43,000 hectares of land on which cane is produced and contracts with individual farmers for the purchase of cane grown on 50,000 to 75,000 hectares. Prices received by farmers for cane depend upon sugar prices in domestic and foreign markets and also on a minimum support price. Farmers receive as payment for the cane they sell to the Taiwan Sugar Corporation 55 percent of the refined sugar. The remaining 45 percent is retained by the Taiwan Sugar Corporation as payment for refining. The farmers' share of the sugar is divided into two parts. Farmers receive one part in kind and can sell it domestically for a relatively high price. A second part, for which farmers usually get a much lower price, is exported. The total domestic supply of sugar comes from the farmers' share, and it is limited to about 120,000 metric tons a year to maintain the price at about \$175 per ton. In 1966, sugar received by farmers in kind for sale domestically accounted for 22 percent of the sugar produced from the sugarcane they supplied refineries. The remainder went into exports and for this part (33 percent) farmers were assured a minimum support price of \$96 a metric ton. The relatively low marginal price for sugarcane to farmers has caused many to shift land from sugarcane to other crops in the last few years.

TOBACCO.—The Tobacco and Wine Monopoly Bureau, a Government enterprise, makes contracts with individual farmers for the purchase of tobacco leaves at specified prices. Tobacco acreage is limited to the acreage required to supply domestic needs. Some tobacco is imported to provide the desired mixtures for cigarettes and other tobacco products. The Tobacco and Wine Monopoly Bureau grades, manufactures, and distributes all tobacco products made in Taiwan. Leaf tobacco is marketed locally to the Bureau through farmers' associations, and farmers' associations make the payments to farmers. Prices to farmers are established to cover estimated production costs.

JUTE.—The Provincial Supply Bureau, another Government enterprise, contracts with individual farmers for the production and purchase of jute from which gunny sacks and other containers are made. Jute is marketed by farmers through farmers' associations. Prices to farmers are set to cover estimated production costs. Payments to farmers are made through farmers' associations.

MUSHROOMS.—This is another crop handled by farmers' associations. The mushroom price is announced before the planting season. Farmers' associations contract the sale of mushrooms to private canneries. Farmers haul their mushrooms to nearby collection stations where they are picked up by farmers' associations for delivery to canneries. Payments to farmers are made through farmers' associations. Mushrooms that do not meet export quality standards when graded by cannery inspectors at collection stations are sold by farmers for local consumption. Local prices of mushrooms are not supported.

PINEAPPLES.—The Taiwan Pineapple Corp., a private enterprise, handles a large share of the pineapples canned for export. A canners' association sets production goals each year for canned pineapples and determines canners' purchase price for raw pineapples. Purchase prices are announced before harvesting seasons.

FRUITS AND VEGETABLES.—Cooperative marketing associations handle most exports of fresh and canned fruits and vegetables. Export operations are planned and coordinated by the Federated Council of Cooperatives in collaboration with Government agencies. Exports of bananas, citrus fruit, and vegetables must pass inspection and meet high quality standards. The Council of Cooperatives has entered into marketing agreements to supply Japanese importers with large quantities of high quality bananas at specified prices. Local farmers' associations assist with collection and grading and channel payments to farmers. Although there are no price support programs for fruit and vegetables, control over quality assures farmers high prices for exports. Products that do not qualify for export are sold domestically by cooperatives. In addition, many private individuals and companies sell fruit and vegetables locally.

FIELD CROPS.—Taiwan's production of peanuts, soybeans, wheat, rapeseed, and similar crops are marketed mainly through farmers' associations. There are no price support programs for these crops. Large imports of cotton, wheat, soybeans, corn and other feed grains affect local prices. However, the Foreign Exchange and Trade Commission limits imports of agricultural products and thereby influences local prices. The Provincial Food Bureau handles imports of soybeans and feed grains and distributes oilcake and feed grains through township farmers' associations.

LIVESTOCK AND POULTRY.—Marketing facilities for livestock, poultry, and eggs are not as well developed as those for crops. Farmers' associations assist farmers in marketing hogs. The distribution of oilcake and other high-protein feeds by the Provincial Food Bureau encourages production of hogs and poultry. The Provincial Supply Bureau purchases hogs for export.

Growth in Market Demand

Market demand for farm products has increased steadily, not only because of domestic population and income growth but also because of well-developed export markets. During the 1920's, the Japanese Government encouraged expansion in sugarcane production to meet consumption needs in Japan. During the 1930's and early 1940's, expansion of rice production was emphasized to provide exports to Japan. Similarly, production of bananas, canned pineapple, and other agricultural products was stimulated by export markets in Japan. Although prices to farmers were not high, they did not decline as output increased, because export market demand continued.

Since 1945, domestic demand for food has been increasing at an annual rate of 5 percent or more each year. In addition, export markets have continued to be important. Policies to diversify agricultural production and exports, including increased emphasis on exports of mushrooms, bananas, canned pineapple and asparagus, and other fruits and vegetables have provided farmers with new market outlets in recent years.

Farmers in Taiwan market a large share of the products they produce. According to unpublished data from the 1956 sample census of agriculture, the share of production marketed off farms ranged from a high of 95 percent for pineapples and citrus fruits to a low of 15 percent for sweet potatoes, which are grown mainly for animal feed. The proportions for other major crops were: rice, 50 percent; peanuts, 56 percent; soybeans, 74 percent; and wheat, 83 percent. Nearly all of the sugarcane is marketed.

Most farmpeople in Taiwan consume enough food to satisfy caloric requirements and meet most nutritional needs. This has been true for many years. Consequently, there is little perverse response to price or little tendency for farmpeople to withhold for consumption more of what they produce, even when prices rise enough to allow them to meet cash expenses with smaller sales. Farmers generally are anxious to sell more when their production increases, in order to step up consumption of items other than food.

Price and Income Incentives

Prices of farm products moved upward gradually from 1911 to the 1920's, but then declined together with world prices in the early 1930's. They moved upward slowly in the late 1930's and early 1940's and then shot upward rapidly after 1943 with wartime shortages in supplies of farm products. Data on prices paid by farmers for production inputs and consumption goods are not available for these early years. However, index numbers of agricultural product prices and wholesale prices of all commodities (1935-37=100) for selected years were as follows:

Year	Agricultural price index	Wholesale price index
1911.....	60	52
1921.....	110	118
1929.....	106	100
1931.....	68	80
1939.....	135	152
1941.....	164	187
1945.....	508	2, 721

Price inflation was a serious problem from 1944 until 1950, primarily because of drastic declines in food production during World War II. However, rapid recovery and expansion of agricultural production

after 1950, together with rationing of food supplies, brought price inflation under control by 1952.

Since 1952 prices received by farmers have moved upward at about the same rate as prices paid by farmers (fig. 10). In the last few years prices received have gone up a little more than prices paid.

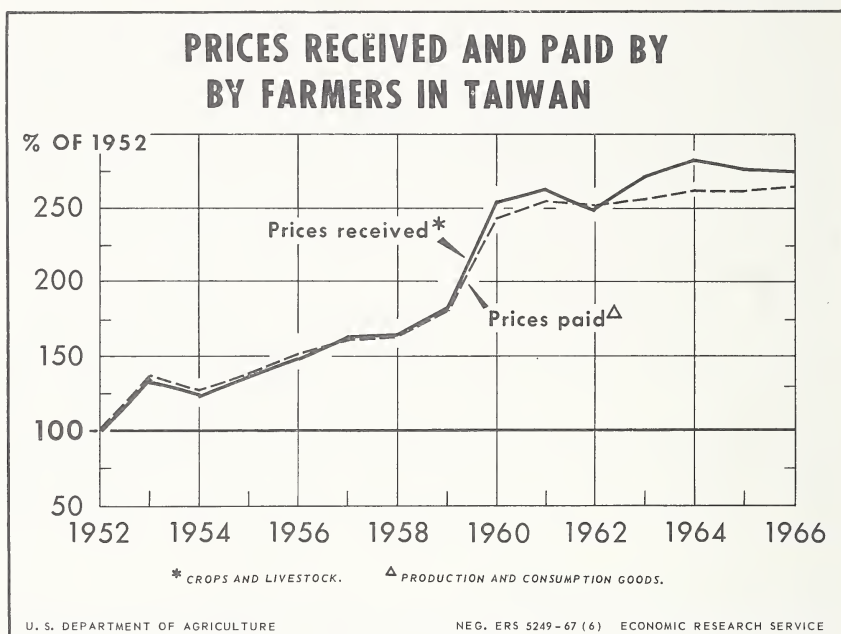


FIGURE 10

It is significant that total agricultural output has increased steadily except for the decline during World War II. The general decline in farm product prices in the early 1930's did not have much apparent effect on total agricultural output. As pointed out earlier, agricultural output went up rapidly during the 1930's. Expansion in the irrigated land area, the introduction of new improved crop varieties, and increased availability of fertilizer and other inputs were the dominant factors affecting agricultural production. Obviously, price ratios between crop products and fertilizer and other capital inputs were favorable enough to cause use of fertilizer and other materials to increase. But the major reason why use of fertilizer went up was that its use resulted in large increases in production. Larger supplies of irrigation water and the introduction of new, improved crop varieties caused production responses from the use of fertilizer to be relatively high. Of course, effective organizations for marketing farm products and distributing farm supplies also contributed to output expansion.

Real incomes of farmpeople went up with the growth in agricultural productivity, but they did not go up as much as they would have if all of the economic gains from productivity increases had been used to increase agricultural incomes. As explained earlier, productivity gains in agriculture provided an economic surplus, a large part of which was transferred to other sectors. Detailed data on growth in real incomes of farm people are not available except for the years since 1950.

Food consumption per capita increased about a fourth from 1911 to 1930 and then declined to the 1911-15 level in 1940-42. It recovered to the 1938 prewar record level in 1951 and has gone up about 20 percent since then.

The transfer of much of the economic gains from increased agricultural productivity to other sectors has been achieved through price programs, land taxes, and other arrangements. Collections of rice by the Provincial Food Bureau at official prices, which have averaged 20 to 30 percent below free market prices, have been an important source of Government revenue for use in general economic development programs (table 26). The preempted farm value of rice collected from farmers in 1965 was equal to about 8 percent of the total farm value of all rice produced in 1965.

How does one explain rapid growth in agricultural output and productivity despite the lack of more favorable price and income incentives? The answer appears to be that the technological innovations that farmers could apply to improve their incomes were profitable

TABLE 26.—*Brown rice prices, rice collected from farmers by Government, and preempted farm value of rice collected by Government, 1952-65*

Year	Brown rice prices			Rice collected from farmers by Government	Preempted farm value of rice collected by Government ¹
	Farm price	Official price	Price spread		
	NT\$ per metric ton			Thousand M.T.	Million NT\$
1952-----	1, 835	1, 156	679	429	291
1953-----	2, 871	1, 647	1, 224	496	608
1954-----	2, 481	1, 916	565	554	313
1955-----	2, 595	1, 956	639	519	331
1956-----	2, 860	2, 047	813	520	423
1957-----	3, 074	2, 139	935	535	501
1958-----	3, 212	2, 314	898	545	489
1959-----	3, 382	2, 449	933	513	479
1960-----	5, 027	2, 940	2, 087	466	973
1961-----	5, 372	3, 648	1, 724	573	988
1962-----	4, 951	3, 780	1, 171	596	698
1963-----	5, 153	3, 858	1, 295	566	732
1964-----	5, 359	3, 937	1, 422	670	952
1965-----	5, 407	4, 042	1, 365	653	892

¹ Price spread multiplied by quantity of rice collected from farmers by Government.

Source: Compiled by Rural Economics Division, JCRR.

with the prices for inputs and products that prevailed. Individual farmers learned that use of improved varieties, fertilizer, and pesticides caused their net incomes to be higher than they would have been if they had not increased their use of these inputs. Assured market outlets at stable prices have been fully as important as the level of prices for farm products in providing incentives to farmers.

Heavy pressure of population on land resources apparently also was a major factor affecting intensity of land use. Individual farmers found it necessary to grow more of the crops that have a high value per hectare and use more purchased capital inputs to maintain as well as to improve their incomes.

Fertilizer Inputs

According to data from the study of 600 farm recordkeeping families, farm expenses for fertilizer in 1965 averaged over \$120 per hectare, compared with less than \$18 for irrigation water and \$17 for pest and disease control.

Chemical fertilizer was first introduced to Taiwan by the Japanese Government in 1902 and distributed to sugarcane growers free of charge (37). Sugar corporations supplied fertilizer to sugarcane growers at subsidized prices beginning in 1904, but these subsidies were discontinued in 1916 when farmers generally came to recognize the value of fertilizer in stepping up crop yields. Fertilizer consumption in Taiwan reached a prewar peak of 649,000 metric tons in 1938. It declined during World War II but recovered rapidly after the war and increased to 805,000 metric tons in 1964 and 767,000 tons in 1965.

The effects of fertilizer use on crop yields are illustrated by changes in rice yields associated with changes in amounts of fertilizer applied per hectare of rice from 1938 to 1966 (fig. 11). It should be recognized, however, that other changes, such as reductions in supplies of irrigation water, also reduced rice yields from 1938 to 1945. Higher rice yields accompanied increased fertilizer use from 1952 to 1966. On the average, rice yield per hectare increased nearly 4 kilograms for each kilogram of fertilizer materials used. The plant nutrient content of fertilizer materials is not known. However, if it is assumed that the average was 30 percent, each additional kilogram of plant nutrients (3 kg. of fertilizer) added about 13 kilograms of rice to production per hectare.

Approximately 75 percent of the fertilizer used in Taiwan has been used for rice, about 15 percent for sugarcane, and about 10 percent for other crops. However, use of fertilizer for other crops is becoming relatively more important.

Taiwan ranks high among countries in fertilizer use. Much more is used per hectare than in such developing countries as India and Pakistan. However, application rates are lower in Taiwan than in Japan, Netherlands, Belgium, or West Germany. Plant nutrients

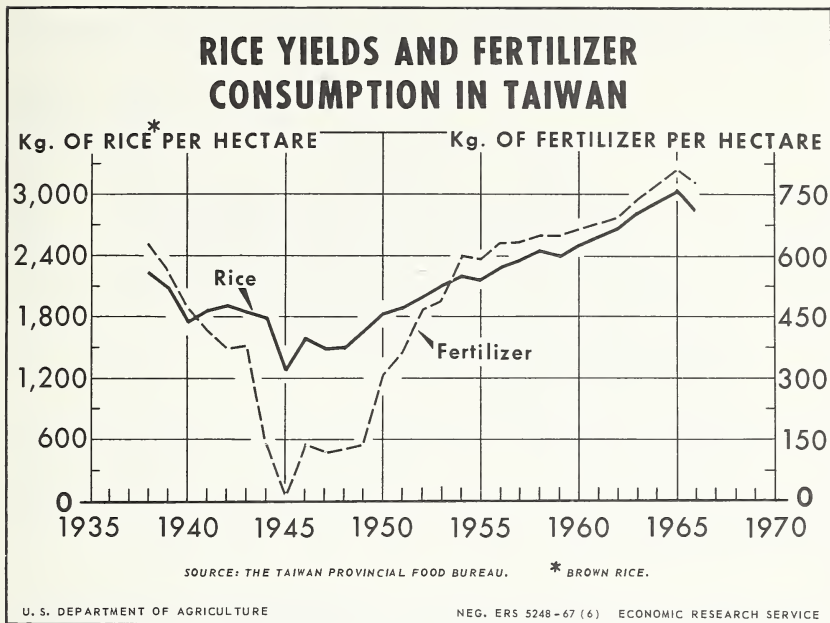


FIGURE 11

applied in selected countries were:

	<i>Kg. per hectare</i>
Netherlands	557
Belgium	501
West Germany	328
Japan	304
Taiwan	237
United Kingdom	154
United States	55
India	4
Pakistan	4

Prices paid by farmers for fertilizer average higher in Taiwan than in most countries (table 27). Taiwan relied upon imports for its fertilizer supplies before 1952. However, domestic production in Government-owned plants has increased. Local production of nitrogenous and phosphatic fertilizers was sufficient to meet domestic requirements in 1964 and only potash fertilizer was imported. Some fertilizer was exported, beginning in 1959. The relatively high prices of fertilizer in Taiwan may reflect the fact that costs of manufacturing facilities are being paid off rapidly. The relatively high fertilizer prices in Taiwan may also account for lower rates of use than in other countries.

Fertilizer prices have been reduced in recent years. For example, the quantity of paddy rice exchanged for 1 kilogram of ammonium sulfate under the fertilizer-rice barter program has been reduced from

TABLE 27.—*Prices paid by farmers per 100 kilograms of plant nutrients, selected countries, 1964-65*

Country	Ammonium sulfate	Superphosphate	Potash, muriate
	<i>U.S. dollars</i>		
Taiwan.....	44. 00	23. 60	12. 50
Japan.....	26. 40	24. 40	9. 70
Netherlands.....	28. 30	21. 50	9. 20
Belgium.....	27. 00	16. 90	8. 20
United States.....	27. 80	22. 30	9. 80
India.....	36. 70	30. 90	13. 10

Source: Food and Agriculture Organization. *Production Yearbook*, 1965. FAO, U.N., Rome, 1966.

1.5 kilograms in 1948 to 0.86 in 1966. However, fertilizer prices to farmers still are high, compared with those in most other countries. It may be that application rates would increase if fertilizer prices were lower. This of course would depend upon responses in crop yields to heavier applications.

CHAPTER X.—AGRICULTURAL DEVELOPMENT PROBLEMS AHEAD

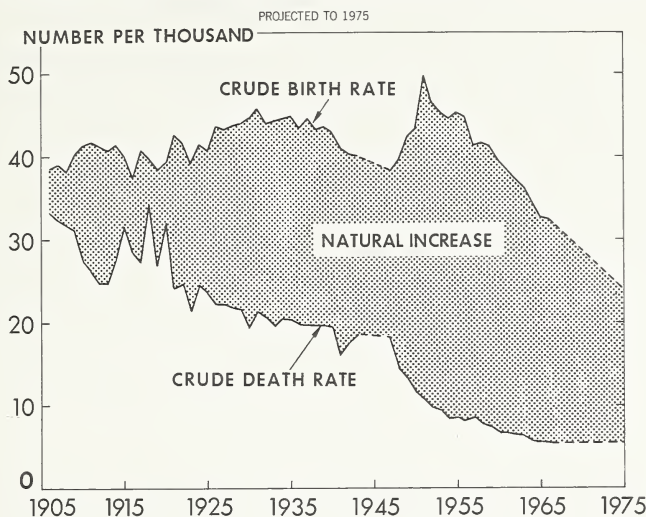
Taiwan has been unusually successful in expanding agricultural production and in increasing agricultural productivity, but this does not mean that Taiwan has no agricultural development problems in the years ahead. Population growth still is rapid and land resources are severely limited. Ways must be found to push agricultural productivity to even higher levels. Questions arise concerning what agriculture's role should be in future economic development. Can agriculture continue to be a source of funds for investment in other sectors? How much scarce capital should be invested in agriculture as compared with industry?

Future Population Growth

Changes in population growth rates in Taiwan in the next few years may have important effects on total food requirements and on the number of people dependent upon agriculture for employment. How rapidly population increases in the future of course will depend upon what changes occur in the relation of birth rates to death rates.

Natural increase in population was only about 1 percent a year from 1905 to 1920 when the crude birth rate averaged a little over 40 per 1,000 persons and the crude death rate averaged around 30 (fig. 12). However, death rates declined to around 20 per 1,000 persons in the late 1920's and early 1930's and the natural increase in population went up to over 2 percent a year. A further drop in death rates to below 10 per 1,000 in the early 1950's, combined with birth rates over 40,

NATURAL POPULATION INCREASE IN TAIWAN



U.S. DEPARTMENT OF AGRICULTURE

NEG. ERS 5365-67 (9) ECONOMIC RESEARCH SERVICE

FIGURE 12

caused natural increases of over 3 percent a year. In 1966 birth rates declined to 32 and deaths to 6, an increase of 2.6 percent.

The reductions in birth rates that have occurred in the last few years with the introduction of family planning programs are impressive. Death rates cannot be reduced much more. In fact, they may rise as the average age of the population increases. It is anticipated that birth rates will decline to about 24 per 1,000 people by 1975 with further expansion of family planning programs. Natural increase in population may decrease to about 1.8 percent a year by 1975.

Agricultural Output Needs

Food requirements will depend upon income growth as well as upon population growth in the years ahead. Real income per capita is forecast by Taiwan to reach \$285 in 1974, compared with \$189 in 1966—an increase of 50 percent, or 5.2 percent a year on a compound growth rate basis. If population increases 2.1 percent a year on the average from 1966 to 1974, and per capita income 5.2 percent, and the income elasticity of demand for food is 0.4, food supplies will need to increase 4.2 percent a year to meet growing domestic demands. In addition, Taiwan will find it desirable to increase agricultural production for export markets and earn as much foreign exchange as possible.

Projected output requirements appear very large, but they correspond closely with past trends. During 1958–66, population increased 3.3 percent a year, real income per capita 5.7 percent, and total agricul-

tural production (including fishery and forestry production) 5 percent. However, total crop and livestock production, or what has been referred to here as total agricultural output, increased about 4 percent a year. On an overall basis, expansion in agricultural production was rapid enough to meet rising economic demands for agricultural products, but significant changes in the composition of agricultural exports and imports took place. Wheat, soybeans, and feed grains have become important import commodities, while exports have been diversified to include more fruit, vegetables, and forestry products.

Achievement of the income growth rates referred to above will depend heavily upon expansion of agricultural production. The agricultural sector accounted for 26 percent of total output in 1966. Much economic activity in manufacturing and service industries depends upon agricultural raw materials or is concerned with supplying inputs for agriculture.

Labor Productivity

A declining rate of population growth would greatly affect the labor force in agriculture, sizes of farms, and mechanization. Agricultural population increased 19 percent in 1958-66, although agriculture's share of total population decreased from 49 percent in 1958 to 45 percent in 1966. If total population increases 2.1 percent a year and non-agricultural population increases 4.2 percent a year in 1966-74, as in 1958-66, total agricultural population will begin to decline. In fact, agricultural population in 1974 would be 8 percent less than in 1966. Population would change as follows:

Population	1958	1966	1974
	<i>Thousands</i>		
Total	10, 039	12, 993	15, 368
Nonagricultural	5, 158	7, 187	10, 011
Agricultural	4, 881	5, 806	5, 357

These projections assume that natural growth rates are the same for the agricultural as for the nonagricultural population. Approximately 40 percent of the total population is now 15 years of age and under, and this proportion can be expected to decline. Consequently, total labor force likely will increase more than total population.

A decline in the agricultural population would provide opportunities for expanding sizes of farms even though the cultivated area does not increase. Or, if farms do not change in size, it would provide opportunity for reducing the number of workers per farm. Mechanization of farming operations and average productivity of farmworkers would increase. Incomes of farmpeople would be expected to rise more rapidly than in the past.

How expansion in sizes of farms would affect total agricultural out-

put and productivity is uncertain. Farmworkers would have opportunities to become more fully employed. There might be some tendency to shift toward labor-extensive enterprises if the number of farmworkers decreases. On the other hand, higher incomes per farm might mean larger capital investments in farming and therefore larger increases in agricultural output and productivity than in the past.

Reduction in population on farms would represent a turning point in Taiwan agriculture. However, it should be recognized that this reduction depends upon a slowing down of population growth and continued rapid growth of employment opportunities in industry. If population growth does not slow down as much as projected above and the number of farmworkers increases, Taiwan will be faced with serious problems of finding productive employment for farmpeople.

Sources of Increased Output

Expansion in agricultural production will need to come mainly from land now in cultivated use. The fourth 4-year plan for economic development shows a target for development of new land of about 12,000 hectares during 1964-68, but new land brought under cultivation may be largely offset by losses of cultivated land to industrial and urban uses (3).

Increased crop production per hectare of cultivated land can be achieved in two ways: (1) Increasing the crop area by additional multiple cropping, and (2) increasing crop production per hectare of crop area by higher yields or by shifting to labor-intensive crops that have a higher value per hectare. As pointed out earlier, crop production per hectare of cultivated land increased 3.5 percent a year from 1951-55 to 1961-65 (table 6). Increases in the multiple-cropping ratio caused crop production to go up a little less than 1 percent a year and increases in crop production per hectare of crop area caused crop production to go up 2.7 percent a year.

In the next few years, increased multiple cropping may generate a 1-percent increase a year in total crop production.

There apparently are no reasons for expecting that dramatic new discoveries or technological breakthroughs will quickly increase crop yields. In the past, yields of most crops have moved upward gradually at a growth rate of a little less than 2 percent a year (table 11). A 2-percent increase a year may be about as much as can be expected in the next few years. Shifts to crops like fruits, vegetables, and tobacco, which have a high value per hectare, also will be needed to cause crop production per hectare of cultivated land to increase more than 3 percent a year. However, shifting land to these labor-intensive crops will depend heavily upon expansion in export demand for them. In any event, continued support of agricultural research and extension will be necessary to increase crop yields.

Expansion in hog and poultry production, made possible in part by imports of feed grains and soybeans, has been an important source of increased agricultural output in the last decade (table 5). It could become much more so in the future. Potentials for expanding production of feed concentrates in Taiwan are limited, but importing more feed concentrates to produce more animal products for export may be a way for Taiwan to step up its agricultural output and productivity. There also are potentials for expanding dairy and beef production by utilizing sloping land more intensively for roughage feed production. However, economic returns from investments in sloping land cultivation and grazing are not known.

Capital Requirements

Capital investments for land and water development and improvements will be required to make possible further increases in crop production on the present cultivated area, and in the years ahead to bring new land into cultivation as agricultural land shifts to industrial and urban uses. Economic returns from these kinds of investments must be compared with returns from investments in industry. Because of shortages of capital for investment in agriculture, it will be especially important to utilize available rural labor as fully as possible to carry out land improvements.

As pointed out earlier, gross capital formation or investment in agriculture (excluding forestry and fisheries) averaged around 5 percent of the total value of agricultural production in 1953-65 (table 22). Approximately half was investment by individual farmers and about half was investment by Government agencies and enterprises associated with agriculture for flood control and irrigation, machinery and equipment, and marketing facilities. It appears that capital investment in agriculture will need to continue to be at least as large as in the past if total agricultural output is to increase 5 percent a year. If Government investments are not continued, private farm investments would need to increase greatly.

There are wide differences among irrigation associations in the fees charged for irrigation water. This may be due to differences in the costs of supplying water. However, irrigation fees generally do not cover the total costs of irrigation water. Government subsidies cover part of the construction costs and they vary among areas. Perhaps more efficient use would be made of available irrigation water if farmers were required to pay the full costs.

Expansion in agricultural production also will require increased use of fertilizer, pesticides, and other materials. The physical potentials for achieving higher yields of rice and other crops by applying more fertilizer are not well known. It is possible that farmers would use much more fertilizer and achieve much higher yields if prices paid for fertilizer by farmers were reduced relative to prices received by

them for rice and other crops. Present prices and marketing policies for fertilizer and rice tend to reduce rice acreages as well as the quantity of fertilizer applied per hectare of rice. High fertilizer prices also affect the quantities of fertilizer used for other crops.

Foreign Trade Opportunities

Taiwan has taken advantage of opportunities to expand production and exports of fruits and vegetables which have a high value of production per hectare and provide productive employment for much labor which otherwise would not be utilized. Investments in processing, transportation, and marketing facilities for fruits and vegetables and the establishment of high grades and standards for exports have paid high dividends. But questions arise concerning the extent to which export demand for these commodities will increase in the future. Taiwan has physical potentials for greatly expanding production of bananas, citrus fruit, pineapples, and other fruits and vegetables, but further expansion of export outlets will be necessary to make large increases in production of these crops economic.

Low and variable prices for sugar in world markets have made desirable the growth of other crops on much land formerly used to grow sugarcane. How many resources to devote to sugarcane production is a major question facing Taiwan. Further reduction in sugarcane acreage may be economic in the years ahead.

Further expansion in imports of wheat, soybeans, and feed grains will tend to raise overall productivity levels in Taiwan's agriculture. Larger imports of feed grains and soybeans would provide much needed protein feed to step up efficiency of swine and poultry production and at the same time provide productive employment for farmworkers. Domestic demand for animal products undoubtedly will increase with higher per capita incomes. There also are export market possibilities for animal products in Japan and other nearby countries but sizes of these markets are not well known.

Larger imports of wheat would make possible larger exports of rice. Because prices of rice likely will average higher than those for wheat in world markets, larger imports of wheat and larger exports of rice will be economically advantageous. However, this will require shifts in dietary habits in Taiwan.

Taiwan is a relatively small island and does not have the opportunities that many large countries have for specialization and trade among regions. Taiwan's development in the next decade will depend, as it has in the past, on how well foreign trade opportunities are exploited.

Agriculture's Role

Taiwan is gradually becoming an industrialized country. If the population projections referred to above are realized, agricultural population will account for only 35 percent of total population in

1974. Taiwan's limited land resources pose questions about the role of agriculture in future economic development. Taiwan has about as much arable land per capita as the Netherlands and only slightly more than Japan. Japan and the Netherlands are industrial countries that depend heavily on imported agricultural products. Taiwan's economy needs to become gradually more like those of Japan and the Netherlands, using exports of industrial products to finance imports of agricultural raw materials. However, it will be essential to increase agricultural productivity wherever possible in order to maximize overall economic growth.

CHAPTER XI.—TAIWAN'S AGRICULTURAL DEVELOPMENT STRATEGY

Heady (12) has pointed out that agricultural development is not a mysterious process. He says, "The important ingredients are rather obvious; the factors to stress are evident." They include improved technology, education, fertilizer and other capital inputs, credit, markets, incentive prices, and so forth. But Heady goes on to say, "What is less obvious is how to overcome the political, cultural, and intellectual restraints which prevent nations from boosting agricultural productivity."

Taiwan's agricultural development record over the last half century indicates that the country found ways of overcoming restraints to advances in agricultural productivity. It is important to recognize that these restraints are largely beyond the control of individual farmers. Schickele (29) points out that the institutional environment affecting education, markets, land tenure, credit, and other rural conditions in many developing countries is such that individual farmers and farmworkers are helpless to overcome obstacles to agricultural progress. Economic progress in agriculture requires modification of the existing institutional environment so that improved technology is generated, individual farmers can put it into effect, and they are rewarded for doing so.

Enlightened Government leadership in Taiwan played a principal role in bringing about institutional changes that were required to overcome obstacles to increasing agricultural output and productivity. Efficient island-wide organizations were set up to provide farmers with education and improved technology, irrigation and flood control systems, fertilizer and other capital inputs, markets for farm products at incentive prices, credit at reasonable interest rates, and a land tenure system that rewarded farmers for their work. The emphasis placed upon education and training in public administration as well as in agricultural sciences made available large numbers of technically competent people for planning and carrying out agricultural improve-

ment programs. Farmpeople responded positively to economic incentives and readily made changes in their farming operations when it was economically advantageous for them to do so.

The agricultural development strategy followed in Taiwan can best be described as an integrated package approach which gives attention to all conditions standing in the way of agricultural progress as opposed to a single-factor approach which emphasizes only agricultural research, extension, or price incentives. Johnson (18) has described the package approach under the broad headings of knowledge, incentives, and means. Brewster (5), in advocating a package approach, says it divides broadly in two parts as follows:

A combination of improved technologies and related skills required for a more effective conquest of nature and a set of organizations which makes possible the improved technologies by linking rural villages and the outside world in a vast network of service exchanges.

Another way of characterizing Taiwan's agricultural development strategy is to describe it as technological and organizational. New technology which could raise productivity per worker and per hectare was developed and new organizational systems for getting superior technology used on farms were put into effect.

The integrated package approach followed in Taiwan to achieve agricultural development can be described under six major headings: (1) Infrastructure development, (2) experimentation, demonstration, and extension, (3) economic incentives, (4) farmer service organizations, (5) agrarian reform, and (6) planning and programming at national and local levels. What follows summarizes much that has been said before in this report.

Infrastructure Development

Large public investments for land and water development, transportation, education, and health and sanitation facilities were made in Taiwan in the early 1900's. These are things rural people acting individually can do little about. It is generally recognized that these facilities need to be financed by the Government. But in Taiwan public investment in irrigation, flood control, and drainage was no less essential for agricultural development.

Government organizations played a major role in planning, financing, and carrying out large-scale irrigation, flood control, and drainage projects. Once these projects were completed, irrigation associations of farm members were organized. Individual farmers who received irrigation water paid water fees to cover costs of operation, maintenance, and repair of irrigation systems, but these fees were not large enough to cover the original investment costs. Most of these costs were paid for out of general taxation. At present, Government banks and agencies make loans at relatively low interest rates

to irrigation associations for irrigation, flood control, and drainage projects.

In addition to general education to increase literacy of rural people, vocational agricultural schools provided a trained staff for agricultural extension work and for assisting with agricultural research projects. Because vocational agricultural students came from farms, they had an intimate knowledge and a sympathetic understanding of farmers' production and market problems. The establishment of vocational schools to provide large numbers of trained agriculturalists well qualified to staff farmer service organizations was an essential infrastructure development.

Experimentation, Demonstration, and Extension

The introduction of technological and organizational innovations in Taiwan may best be described as a three-stage process—experimentation, demonstration, and extension. In the case of new, improved seeds, for example, agricultural experiment stations carry out the basic plant breeding research. The district agricultural improvement stations located in different parts of the island carry out field tests to make sure that the new varieties are adapted for local climatic and soil conditions. Field demonstrations on farms are then conducted to demonstrate to farmers the superiority of the new seeds. Only after it has been clearly shown that the new varieties have higher yields or other advantages are large-scale seed multiplication and distribution programs put into effect.

The three-stage approach has been used widely to improve rice and hog production. Under the integrated rice improvement program a package of improved practices was designed by agricultural improvement stations. Demonstrations in farmers' fields showed that rice yields could be increased 30 percent. The packages of improved practices were then introduced on blocks of 12 to 25 hectares. Yield increases of 15 to 20 percent have been achieved in 1 year. To improve hog production, farmers were told about and bought improved breeds and oilseed cake to step up the protein content of feed rations, and they followed instructions of extension workers on housing and disease control. Rapid growth, meat-type hogs, and increased efficiency in feed conversion resulted. Farmers paid all costs of the new inputs except for extension advice, and found the package of improved practices highly profitable.

The same approach has also been used to achieve worthwhile organizational changes. It was used, for example, in the land reform program which involved, first, rent reduction; second, sale of public land to tenants; and finally, the land-to-the-tiller program.

In the case of the unified agricultural credit program, experimental programs were first tried with a few farmers' associations to test new arrangements for improving farm credit before they were introduced

on a large scale. The land consolidation and improvement program now in progress was tried out on a small scale to test procedures and demonstrate benefits to farmers before it was extended on a large scale. The integrated rice production improvement program involving joint-farming operations is another example of the experimentation-demonstration-extension approach to achieving organizational changes that increase agricultural productivity.

Economic Incentives

Development of local markets for all the products farmers could furnish, and the provision of improved seeds, pesticides, fertilizer, and other materials, created economic incentives for farmers to apply new technology and increase agricultural productivity. Assured market outlets and reduction of price uncertainty were especially important in providing economic incentives to farmers. Prices of farm products have been maintained at levels high enough to make the use of fertilizer, pesticides, and other materials profitable for individual farmers. The use of new improved seeds, fertilizer, pesticides, and other materials has been subsidized at the outset to help get new technology adopted. The development of local farmer service organizations and agrarian reform affecting land tenure, credit, and marketing arrangements all have helped bolster economic incentives.

Farmer Service Organizations

Farmers' associations, fruit marketing cooperatives, and irrigation associations were established with assistance from and direction by Government agencies.

The 341 township farmers' associations covering all major agricultural areas of the island are multiple-purpose cooperatives, controlled by farmer members, with three main departments: (1) Economic sections to purchase and market farm products and sell farm supplies and consumption goods, (2) credit sections to receive deposits of members and make loans, and (3) extension sections to educate farmers on new technology.

The specialized fruit marketing cooperatives are concerned primarily with the marketing and processing of fruit and vegetables, but they also conduct some research and provide advisory services to farmers in producing and marketing these commodities. They help gear production and marketings to prospective export and domestic outlets.

Farmers' associations are the local organizational units through which many Government agencies carry out their programs. For example, the Provincial Food Bureau carries out its rice price stabilization program and its fertilizer-rice barter program through farmers' associations. Township farmers' associations receive, mill, and store rice delivered to the Provincial Food Bureau as payments

for land taxes, deliveries under the compulsory purchase program for price stabilization, and deliveries under the fertilizer-rice barter program. Similarly, the Tobacco and Wine Monopoly Bureau contracts with individual farmers to grow tobacco through farmers' associations. Farmers' associations handle, store, and pay farmers for tobacco in behalf of the Tobacco and Wine Monopoly Bureau.

Credit departments of the farmers' associations are the local organizational units through which the Unified Credit Program operates to reduce interest rates and increase loan funds available to farmers. They serve as local agents of the Cooperative Bank and the Land Bank.

The extension departments of farmers' associations cooperate with credit departments in carrying out supervised farm credit programs. In addition to general agricultural education activities, they play an important role in such programs as the integrated rice improvement and the integrated swine improvement programs.

Farmers' associations strengthen the bargaining position of farmers in selling farm products and assure a market outlet for all that is produced. They also have proved efficient in distributing farm production requisites and consumption goods in competition with other private business concerns.

Agrarian Reform

Rural institutional organizations affecting land tenure, credit, marketing, extension, general education, and local government have undergone many changes, especially since 1945. These changes have helped give farmers more control over their economic operations.

The land reform program under which land rents were reduced and later tenants were able to purchase much of the land they operated was a major institutional reorganization affecting economic incentives and the social welfare of individual farmers. The proportion of farmers who were tenants or part owners decreased from 64 percent in 1949 to 36 percent in 1960.

Reorganization of farmers' associations to give farmers increased control over marketing, credit, and agricultural extension perhaps has been as important as land reform in improving the economic position of farmers. Before retrocession of Taiwan to the Republic of China, landlords and moneylenders dominated marketing cooperatives and played a leading role in marketing farm products and making production loans to farmers. Reorganization of farmers' associations affected economic operations of all farmers and not just those who were tenants.

Agrarian reform programs improved the economic welfare of farmers and provided them with additional income for investing in farm improvements. The rural health program under which medical

facilities in rural areas were greatly improved was especially important in improving rural living conditions.

Planning and Programing

Agricultural development of Taiwan was an objective during the Japanese occupation from 1895 to 1945 as well as during the years since retrocession to the Republic of China. Action programs at the village and farm levels were put into effect to achieve large increases in agricultural production.

The Japanese Government placed heavy emphasis on expansion of sugar production in the 1920's and rice production in the 1930's for export to Japan. As explained earlier, improved crop varieties and use of fertilizer were introduced. Japanese agricultural officials specified a number of improved farming practices which individual farmers were expected to follow. Large infrastructure investments were made for transportation, marketing and processing agricultural products, irrigation, flood control, and drainage as a part of general plans for agricultural development.

Agricultural planning and programing has been improved since 1945. Comprehensive 4-year economic development plans specifying detailed objectives for annual increases in agricultural and industrial production were begun in 1953 (13). In addition, 10-year projections for agricultural development were worked out. These plans and projections include detailed goals with respect to land and labor use, provision of fertilizer and other materials, water and land development, and capital investments. Agricultural development plans are based on careful examination of agricultural production possibilities and potentials and on detailed study of foreign markets and domestic demand and requirements for farm products in the years ahead. Agricultural development plans are carefully coordinated with industrial development plans since agriculture and industry often compete for the same resources.

Increases in total agricultural production, averaging 4.5 percent or more each year since 1953, were achieved primarily because of effective implementation of the development plans at the farm level. Programs have been carried out to make needed supplies of fertilizer, pesticides, and other materials available to farmers. Price relationships among commodities have been adjusted when necessary to achieve shifts in resource use made desirable by changing domestic and foreign markets for farm products. Attention has been given to export opportunities, especially for processed agricultural products, as a means of increasing foreign exchange earnings.

U.S. Aid Programs

U.S. economic aid, technical assistance, and agricultural commodity aid programs administered through the Chinese-American Joint Com-

mission on Rural Reconstruction helped achieve large increases in agricultural output and productivity. Economic aid provided much of the capital required for building up industries that support agriculture. Agricultural commodity aid programs helped save scarce foreign exchange and provided capital for road construction and land and water development projects. Technical assistance, including the training of agricultural technicians in the United States, contributed greatly to the technical competence with which agricultural development programs were carried out. Although it is not possible to estimate how much U.S. aid caused agricultural production to increase, it is evident that Taiwan's agricultural development would have been much slower if foreign aid had not been available.

The Joint Commission on Rural Reconstruction has served as a catalytic agent in accelerating agricultural development by supplying technical assistance and capital resources for carrying out improvements in agricultural research and extension work, fertilizer and other production requisite industries, farm credit and land tenure systems, marketing facilities and arrangements, and land and water resources. In addition, the Joint Commission on Rural Reconstruction has played a leading role in agricultural policy formulation and in agricultural planning and programing. U.S. aid programs in agriculture were well coordinated with those in other sectors (17).

CHAPTER XII.—RELEVANCE OF TAIWAN'S EXPERIENCE FOR OTHER COUNTRIES

Agricultural conditions in Taiwan are similar to those in many developing countries where population growth is rapid and land and capital resources are relatively scarce. Consequently, the lessons learned from Taiwan's agricultural development experience may be expected to have more applications and greater relevance than those gained from study of the more economically developed countries where population growth was much slower and land and capital resources much more abundant. However, organizational arrangements that have been successful in achieving rapid increases in agricultural productivity in Taiwan will not automatically be suitable for transfer to other countries. As in the case of new varieties of crops and breeds of animals introduced from abroad, adaptation of institutional organizations that have been successful in Taiwan may be needed to make them work effectively in other countries.

New Technology

As pointed out by Schultz (30), a continuous flow of new superior technology is essential for sustained increases in agricultural productivity. However, Taiwan's experience indicates that expenditures for agricultural research need not be large. Taiwan now has only one

agricultural research worker for each 800 farmers, and about 30 per cent are vocational agriculture school graduates who do not have a college education.

Taiwan has relied heavily upon the introduction of new varieties of plants and breeds of livestock from abroad and on adaptive research. Fundamental or basic research has been supported on a modest scale. Nevertheless, attention has been given to all phases of farm production and marketing including the development of new superior varieties of crops and breeds of livestock, pest and disease control, chemical fertilizer and compost to build up soil productivity, and effective use of irrigation water.

The high level of agricultural technology in Taiwan today can be attributed in large part to the effective research work of agricultural research institutes and the seven district agricultural improvement stations which are similar in many respects to branch agricultural experiment stations of State agricultural experiment stations in the United States. The researchers are in close contact with production and marketing problems at the farm level, and conduct research of practical and immediate value to farmers. Taiwan's experience indicates that the quality of the research input is much more important than the total volume.

Education and Extension

Taiwan has excellent most prominently in getting new technology adopted on farms. The lag between what is known about improved farming methods that are economic to apply and their application by farmers appears to be very small. The fact that agricultural extension work is closely associated with the provisions of production requisites and credit by farmers' associations apparently accounts for the quick adoption of improved farming methods.

The effective diffusion of knowledge about superior farming methods is a result of effective extension work of farmers' associations. It is significant that there is only one extension worker for each 1,000 farmers and nearly all of them are vocational agriculture school graduates with no college training. Extension workers rely heavily on field demonstrations and work with village leaders in discussion groups. Extension workers report problems they encounter and get assistance from district agricultural improvement stations in carrying out agricultural education programs.

Taiwan's experience with developing improved technology and getting it used quickly on farms suggests that other developing countries should consider the economy of making larger investments in vocational agriculture schools, district agricultural improvement stations, and extension services conducted in close collaboration with farm credit and marketing activities.

Resource Development

Infrastructure investment in irrigation, flood control, and drainage has been especially important in stepping up agricultural output and productivity in Taiwan. Irrigation development is not something individual farmers can do effectively. It requires organized group action and Government initiative and support. In Taiwan, Government organizations have played a major role in developing land and water resources as well as in providing education, research, and transportation facilities. Investment costs for these infrastructure investments have been paid out of public funds. The increased production brought about by these investments has provided a basis for taxation programs to recover the costs of infrastructure investments. It is important to observe that interest rates charged for irrigation development have been set relatively low. Land and water development has been viewed as an infrastructure investment upon which future growth of agricultural production depends.

Densely populated developing countries that have limited land resources and potentials for irrigation development may benefit by following policies similar to those of Taiwan. However, irrigation development in countries like the Philippines and Thailand may require larger outlays for materials than was the case for Taiwan (16). Early irrigation development in Taiwan did not require large amounts of capital or materials. It was carried out chiefly by utilizing labor that otherwise would have been unemployed. Multiple-purpose water development projects like those carried out in Taiwan in recent years of course require large amounts of capital goods.

Capital Inputs

Taiwan's experience indicates that large expenditures for fertilizer, pesticides, tools and equipment, and other materials from nonfarm sources are required to apply new technology and improve agricultural productivity. In 1961-65, working capital inputs accounted for 27 percent of all inputs used in farm production (table 3). Industrial development within developing countries or imports to provide increased amounts of fertilizer, pesticides, and other materials is essential for agricultural development.

Subsidy programs to demonstrate the value of using fertilizer and pesticides and certain tools and equipment may be needed at the outset to get these inputs used. However, in countries where irrigation water is available and improved crop varieties are developed, fertilizer use can result in very large yield responses. Once these yield responses have been demonstrated, farmers may be expected to use large amounts of fertilizer even though fertilizer-product price ratios are less favorable than in the developed countries. In Taiwan, for example, farmers use large amounts of fertilizer even though prices of fertilizer average twice as high relative to prices of rice than they do in Japan.

Well-developed credit systems are needed to facilitate the use of capital inputs required for applying improved technology. However, low interest rates for farm production credit under Government programs may cause inefficient use of capital. High interest rates may reflect high productivity of capital inputs as well as scarcity of capital inputs. In Taiwan, ample credit has been available to finance the use of capital inputs, but interest rates have been relatively high as compared with those in developed countries.

Capital inputs were used to increase output per hectare and not to substitute for labor. Thus far, there has been very little mechanization of farming operations; the large supply of labor, relative to capital and land resources, makes much substitution of machines for labor uneconomic. However, the use of capital inputs to apply improved technology and to increase crop production per hectare indirectly has increased output per farmworker.

Farm Size

Taiwan's experience indicates that farm production organized in many small farm units can be efficient. A structural organization of many small farms has been a strength rather than a weakness in achieving large gains in agricultural productivity. But, these small farms have been surrounded with local service organizations that supplied new knowledge about superior production methods, markets for farm products, production requisites, and credit which enabled them to increase their efficiency. It is especially significant that, although average size of farms decreased by one-half from 1952 to 1966, output per farm was maintained by increased intensity of land use.

Many developing countries where agriculture now accounts for 60 percent or more of total population, with population growth rates of 2.5 percent or more a year and limited land resources, will need to plan for the use of increasing numbers of agricultural workers (7). Farms will need to decrease in size or more workers be employed per farm. Taiwan's experience indicates that increased numbers of small farms may be the most effective way to get increased intensity of land use.

Operators of small farms are often thought to be oriented toward subsistence production and not interested in commercial production for sale. In this connection it is significant that farms with less than 0.5 hectare in Taiwan produce more than twice as much per hectare as farms with over 2.5 hectares. Although small farms do not have as much surplus for sale as large farms, small farms produce as much for sale per hectare as large farms. Small farms do not hold back products for home use when prices for farm products are relatively high, even though reduced sales would cover cash costs. In other words, backward sloping supply curves or perverse responses to price are not characteristic of Taiwan agriculture.

Farmer Organizations

Taiwan's experience in establishing effective farmer organizations for carrying out agricultural improvements should have much value for other developing countries.

Too much emphasis cannot be placed upon the importance of local farmer service organizations in improving marketing facilities, providing farmers with production requisites and credit, and diffusing new knowledge about improved production and marketing methods. In Taiwan these organizations include multiple-purpose farmers' associations, fruit and vegetable marketing cooperatives, and irrigation associations. These organizations have greatly increased efficiency in marketing farm products and in purchasing farm supplies and in addition have greatly increased the bargaining power of farmers. They are under control of farmer members and provide a means for farmers to find solutions to their production and marketing problems.

Similarly, the importance of province-wide farmer organizations in implementing agricultural development plans and programs cannot be overemphasized. Township farmers' associations are members of county farmers' associations, and these in turn are members of the province-wide farmers' association. The provincial farmers' association provides direction and advisory services for member associations. Similarly, the federated council of cooperatives provides leadership and direction for the fruit and vegetable marketing cooperatives.

Farmer organizations provide the means by which Government programs are effectively implemented at the farm level. For example, township farmers' associations have been instrumental in carrying out the fertilizer-rice barter program of the Provincial Food Bureau. They collect and handle rice under land tax and compulsory purchase programs. Government corporations concerned with production and marketing of tobacco, jute, and other crops carry out their programs through township farmers' associations.

Efficient operation of farmer organizations at both the local and island-wide levels in Taiwan must be attributed in large part to a relatively high level of education. Agricultural colleges and vocational agriculture schools provide a large number of well-trained people for staffing the many positions in farmer organizations.

Supporting local services to provide markets for farm products, supplies of production requisites, credit, and extension education are necessary for efficient operation of small farms. If these supporting services are not available, large plantation-type farms that can provide these services themselves may be more efficient. In Taiwan, for example, production of sugarcane on large-scale farms probably was more efficient until local supporting services for small farms could be built up.

Land Reform

Taiwan achieved large increases in agricultural production in the 1920's and 1930's when nearly two-thirds of its fertile paddy land was operated by tenants. However, land reform to put ownership of land in the hands of farmers was essential in the 1950's to assure social stability in rural areas and improve economic incentives to farmers. Rental rates charged by landlords were relatively high and lease arrangements were uncertain from one year to the next before land reform was carried out.

Land reform in Taiwan was successful in increasing agricultural output and productivity for several reasons. Perhaps most important is the fact that supporting services to provide extension education, marketing, credit, and production requisites had been built up. In addition, tenant farmers who became landowners were experienced farm operators accustomed to making managerial decisions. Landlords were paid for land purchased by the Government and were encouraged to make investments in industry. Tenants paid for the land they purchased from the Government over a period of 10 years, but payments for land purchase generally were lower than they had formerly been for land rent.

Taiwan's experience with land reform should be of special interest to other countries where unfavorable tenure arrangements limit economic incentives and discourage investments in land improvements.

Prices and Markets

Taiwan's experience indicates that farmpeople respond to economic incentives. They are not reluctant to discontinue age-old techniques for more productive new ones, once it is demonstrated that the new techniques will be profitable. Moreover, they shift from one crop to another when changes in relative prices make such shifts economically advantageous. Although farmers do not have much formal education, they are very astute in calculating what changes in farming operations will be profitable.

Assured market outlets are as important as the level of farm product prices in providing economic incentives for increasing production. Farm product prices do not need to be very high to make the use of improved seeds, fertilizer, pesticides, or irrigation water profitable where these inputs give very large yield responses and markets are available for the additional output.

The things farmers can do to improve their individual incomes are about the same whether farm product prices are relatively high or relatively low. Of course, prices of farm products need to be high enough relative to prices of new improved seeds, fertilizer, pesticides, and other materials to make the use of these inputs profitable. Moreover, farmers must have enough income or enough credit to finance the new inputs.

Role of Government

Taiwan's experience indicates that national and local governments can play a leading role in accelerating agricultural development. In fact, agricultural output and productivity probably cannot be much improved in most developing countries without strong leadership and support by Government organizations. Not too much emphasis can be placed on the need for well-trained and devoted public servants to staff Government agencies and improve the quality of Government services.

In Taiwan, Government agencies have been concerned with much more than agricultural education, research, and regulation. They have been responsible for planning and carrying out institutional improvements in land tenure, farm credit, marketing farm products, and supplying farmers with production requisites. They exercise much influence over the marketing and price policies. The Provincial Food Bureau, the Taiwan Sugar Corporation, the Taiwan Tobacco and Wine Monopoly Bureau, the Taiwan Tea Corporation, the Provincial Supply Bureau, and other agencies market and process farm products and manufacture and distribute production requisites. Government-owned plants produce most of the fertilizer used in Taiwan. Government agencies give attention to foreign agricultural trade opportunities as well as to domestic demands for agricultural products in developing agricultural production goals and programs for use in national economic development plans. They also lead in planning and carrying out programs for land and water resource development.

The role of Government in agricultural development obviously needs to differ from one country to another. Each country must start with its present institutional arrangements and decide how they should be modified to improve local services to farmers.

Foreign Aid Arrangements

Finally, the approach of the Joint Commission on Rural Reconstruction to agricultural development is an element in the Taiwan experience that should be considered in foreign aid programs to other countries. As pointed out by Montgomery, Hughes, and Davis (27), "JCRR's function has been to administer American aid of all kinds—loans, grants, and technical assistance—to agriculture, rural health, and related projects. Its operations, partly because of its special character as a joint, autonomous, semi-independent organization, seem unconventional when compared with those in other fields of U.S. aid. By providing both funds and advice to projects submitted to it for support, JCRR has been able to respond quickly in areas where a "felt need" was articulated, and by placing the management and operating responsibilities squarely on the shoulders of the 'local sponsoring' or aid requesting agencies, it has stimulated interest on the part of a variety of institutions, public and private, large and small, and at many levels of the society."

The Joint Commission on Rural Reconstruction has had wide authority to disburse funds and provide technical assistance for accelerating agricultural development. In some respects it acted like a foundation, working within broad perspectives and purposes to stimulate, evaluate, and advise on project proposals presented by other institutions that were capable of carrying them out under JCRR guidance. American and Chinese officials worked closely together in program planning and formulation and in project screening in cooperation with private and public officials at all levels of government. There was great flexibility in choice of activities or projects it supported. A high degree of continuity of policy and program was possible. However, it should be recognized that preconditions for an effective joint agency are not encountered universally. Not all countries would be willing to provide a joint agency like the JCRR with the technical support and wide latitude for action necessary for successful operation.

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